November 1, 1991, Volume 199, Number 9

JOURNAL

OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 199 November 1, 1991 No. 9
JAVMA 199 (9) 1113-1232 (1991)
ISSN 0003-1488

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American Veterinary Medical Association
1931 N. Meacham Rd.
Suite 100
Schaumburg, IL 60173-4360
Telephone: 708/925-8070
Telephone toll free: 1-800/248-2862
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AVMA GOVERNMENTAL RELATIONS DIVISION

Dr. William R. Van Dresser, 1023 Fifteenth Street, NW, Suite 300, Washington, DC 20005-2602. Telephone toll free: 1-800/321-1473. Outside the continental United States call 202/659-2040. Fax: 202/842-4360.

SUBSCRIPTIONS: For one year: members $35; others $70 in the United States and possessions; $90 in foreign countries. Single copies: $6.00 in the United States and possessions; $8.00 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1991 by the AVMA.

ADDRESS CHANGE: Send new address (and moving date) 45 days ahead. Include old address as it appeared on previous issues (if possible send label).

POSTMASTER: Send address changes to JAVMA, 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360.

Clinical, clinicopathologic, and pathologic features of plague in cats: 119 cases (1977-1988)

Millicent Eidson, MA, DVM; John P. Thilsted, DVM, PhD; Ole J. Rollag, DVM

Summary: *The clinical, clinicopathologic, and pathologic features of 119 cases of plague in cats from 1977 to 1988 in New Mexico were reviewed. Fifty-three percent were bubonic, 10% were pneumonic, 8% were septicemic, and 29% with neither buboes nor pneumonia were unclassified (but presumed septicemic). Three quarters of the lymphadenopathy was submandibular, and almost half of this was bilateral. One third of all cats had the triad of lethargy, anorexia, and fever in addition to buboes; one quarter had this triad plus abscesses. The overall mortality rate was 33%, with the greatest risk of death in pneumonic cases. For confirmatory diagnosis with a single laboratory test, fluorescent antibody was most frequently used (39% of cases). Cultures and passive hemagglutination titers were also used for confirmation. Gross and histologic findings depended on the type of plague with* Yersinia pestis *organisms visualized in buboes of cats with bubonic plague and in the alveolar spaces and respiratory tubules of cats with pneumonic plague.*

Plague, caused by the bacteria *Yersinia pestis*, is a disease of antiquity, which has decimated the world's human population at various stages in history. Plague continues to be an important disease in many parts of the world today, including the western United States. Most infections of rodents, lagomorphs, human beings, wild and domestic canids and felids, and other animals result from the bites of infected fleas. However, transmission can occur through any blood contact during handling, skinning, or eating infected animals.

Although severe morbidity and mortality for human beings has been well documented for centuries, plague's effects on the health of domestic and companion animals has only recently begun to be understood. It now appears that plague in cats is an important disease impacting the health of cats and their owners as well as veterinary staff who come in contact with them. Sporadic feline plague cases have been reported in the United States and elsewhere.[1-13] Transmission of plague to human beings via the bites of rodent fleas on cats, direct transmission of feline infection through cat bites, or contact with draining abscesses or pneumonic aerosals has been documented in at least 15 cases.[1-5, 7-17] The risk factors for cats acquiring plague infection in New Mexico have been recently reviewed and appear to include hunting rodents, particularly in the summer, in rural areas.[14] The purpose of the study reported here was to determine the clinical, clinicopathologic, and pathologic features of plague in cats.

Criteria for Selection of Cases

After the first laboratory-confirmed plague case in a cat was reported in New Mexico in September 1977, a registry of cases was established by the Office of Epidemiology, New Mexico Department of Health (DOH). Laboratory confirmation for suspect cases was provided by DOH's Scientific Laboratory Division and the New Mexico Department of Agriculture's Veterinary Diagnostic Services. Plague confirmation is not available at any other laboratories in New Mexico, and there were no reports of veterinarians who use out-of-state laboratories for plague testing.

Cases were confirmed with isolation of *Y pestis* from culture material, positive fluorescent antibody (FA) stain from clinical or pathologic material, a

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From the Office of Epidemiology, New Mexico Department of Health, PO Box 26110, Santa Fe, NM, 87502 (Eidson, Rollag) and Veterinary Diagnostic Services, New Mexico Department of Agriculture, 700 Camino de Salud NE, Albuquerque, NM, 87106 (Thilsted)

We thank the following for providing information essential for completing this study: L. Nims, K. Montman, and Drs. M.H. Hume, J.R. Jackson, M. Johnson, K. Blackshear, R. Bouloy, F.H. Coons, R.J. Cortesi, F.K. Sweeney, M.A. Hedberg, T.W. Schukei, C.J. Mabray, and E.T. McKenna, Albuquerque, NM; P. Reynolds, T. Brown, and Drs. J.L. Lauer, R.A. Snook, T.E. Smith, W.J. Arrighetti, P. McCreight, P.J. Hinko, D.W. Krogdahl, B.E. Swanson, S.P. Brandt, R.L. Peterson, and T. Gallegos, Santa Fe, NM; Drs. T.A. Schupbach and W. Wiatt, Taos, NM; Drs. P.L. Curtis and N.E. Hauer, Los Alamos, NM; Dr. D.W. Dessauer, White Rock, NM; Drs. R. Huechen and D. Despres, Cedar Crest, NM; Dr. S.J. Dowds, Tucumcari, NM; Drs. J.F. Wisniewski and B.R. Bowker, Edgewood, NM; Dr. B.G. Thornton, Grants, NM; Dr. F.L. Willard, Ruidoso, NM; Dr. I.R. Sawyer, Raton, NM; Dr. K. Ramsey, Espanola, NM; Dr. K. Podkonjak, Gallup, NM; Drs. E. Staley and E.R. Leslie, Alamogordo, NM; Dr. T.K. Dienlin, Socorro, NM; Dr. A. DeGroot, Sandia Park, NM; and Dr. L. Locklar, Silver City, NM.

fourfold increase in passive hemagglutination titer between acute and convalescent sera, or a single titer of 1:32 or greater with clinical signs compatible with plague infection.

Cases were defined as bubonic if the cat had 1 or more enlarged lymph nodes at clinical or pathologic examination. Because of the substantially increased risk of transmission, pneumonic plague was diagnosed with any clinical, histologic, or radiologic evidence of pneumonia, regardless of whether the lung infection appeared to be primary or attributable to secondary spread. In people with plague, cases of those people without buboes or pneumonia are defined as septicemic. For this study, cases in cats without buboes or pneumonia and without evidence of septicemia were defined as unclassified because feline cases are sometimes not investigated as thoroughly as human cases. Cases were defined as septicemic if the cats were ill and bacteremic as documented with cultures of blood.

Clinical information was obtained from veterinarians and cat owners. Necropsies were performed on available cats.

Results

Signalment—Plague has been reported in 119 domestic cats in New Mexico between September 1977 and Dec 31, 1988 (Fig 1). Affected cats ranged in age from newborn to 15 years, with a mean of 3 years. Sixty-six were males (55%), 38 were females (32%), and gender was unreported in 15 cases (13%). Forty-one percent (49 cats) were reported to be neutered, compared with 16% unneutered (19 cats). Almost half of the cats were reported to be domestic shorthairs (45%, 53 cats). One fifth were domestic longhairs (24 cats), 8 cats were Siamese or Siamese crosses, 5 cats were Manxes, and 3 cats were other breeds. Feline plague cases were distributed throughout most of the state at elevations between 3,500 and 8,600 ft, in 18 of 32 counties, but primarily in the 7-county north-central area (103 cases, 87%).

Clinical findings—The majority of cases (63, 53%) were bubonic without evidence of septicemia or pneumonia. Twelve cases (10%) were pneumonic. Four of these were secondary to bubonic infection, bringing the number of cases with enlarged buboes to 67. The remaining 8 pneumonic cases had no obvious primary focus.

Five of the 12 pneumonic cases were diagnosed clinically by veterinarians, diagnosis of 3 cases was based on the veterinarians' interpretation of radiographs, and diagnosis of 4 cases was based on the identification of *Y pestis* organisms in the alveoli on histologic analysis. Nine cases (8%) with neither buboes nor pneumonia were confirmed to be septicemic with cultures of blood. An additional 35 cases (29%) without buboes or pneumonia did not have cultures of blood submitted to confirm septicemia.

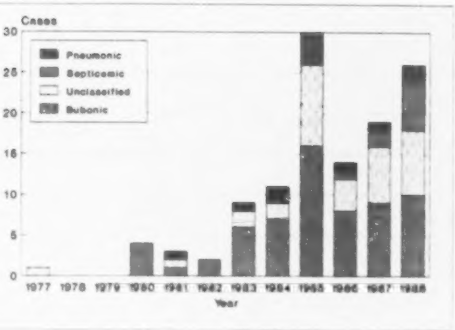

Figure 1—Reported cases of plague in cats in New Mexico from 1977 to 1988 (n = 119).

Of the 67 plague cats with enlarged lymph nodes, 50 (75%) had submandibular lymphadenopathy (Table 1). Nine cats had multiple types of lymph nodes enlarged. Submandibular and cervical buboes were reported in 4 cats, and popliteal and external iliac node enlargement was reported in 2 cats. One cat had enlarged cervical, axillary, and external iliac lymph nodes; 1 cat had enlarged submandibular, prescapular, and popliteal lymph nodes; and 1 cat had enlarged submandibular and external iliac lymph nodes.

Table 1—Lymph node involvement in cats with bubonic plague (n = 67)

Nodes	No. of cases	Bilateral	Right	Left	Unspecified
Submandibular	50	23	5	14	8
Cervical	8	2	0	3	3
External iliac	6	1	1	3	1
Popliteal	6	0	3	2	1
Prescapular	5	0	1	2	2
Axillary	2	0	0	1	1
Unspecified	1	0	0	0	1
Total	78	26 (33%)	10 (13%)	25 (32%)	17 (22%)

Approximately one third of the lymph node enlargement was bilateral, and another one third was on the left side. Right-sided enlargement was reported in only 13% of the cases, although the location of the enlargement was not specified in almost one quarter of the cases. Bilateral involvement was most frequently noticed when submandibular lymph nodes were involved. The other lymph nodes in which bilateral enlargement was noticed were cervical and external iliac.

The size of the lymph node enlargement was reported for 18 cases; ranging from 2.5 to 7.6 cm, with a mean value of 3.8 cm. In 6 cases, the lymph nodes were reported as draining prior to veterinary treatment, compared with no drainage in 32 cases.

Lethargy was reported in 97 cats (82%), anorexia in 92 cats (77%), fever in 85 cats (71%), abscesses in 41 cats (34%), dyspnea in 17 cats (14%), discharge from the mouth or nose in 17 cats

(14%), and coughing or sneezing in 11 cats (9%). The triad of lethargy, anorexia, and fever was reported along with buboes in 40 cats (34%), and along with abscesses in 28 cats (24%). Most of the abscesses were in affected lymph nodes (25 of 41, 61%). Other abscesses were sublingual (5 cases), tongue (1), mouth (2), face (2), lips (1), maxilla (1), gluteal muscle (1), hind limb (1), forelimb (1), fore- and hind limbs (1), thorax (1), and abdomen (1).

Specific temperatures > 39.2 C were recorded in 81 cats. These higher than normal temperatures averaged 40.6 C. Miscellaneous signs reported included (each for only 1 cat): ocular discharge, vomiting, diarrhea, dehydration, coma, ataxia, necrotic stomatitis, facil ulcers, cellulitis, enlarged tonsil, partial alopecia, poor hair coat, massive weight loss, and crepitous body; in addition to oral ulcers (2 cases), swollen tongue (2 cases), and abortions (2 cases).

Survival status varied in relation to the type of plague and antibiotic treatment (Table 2). Although only 10% of the feline plague cases were pneumonic (12 of 119), 21% of the deaths or euthanasias were pneumonic (8 of 39). Septicemic or unclassified (presumably septicemic) cases represented 37% (44 of 119) of the total, compared with 38% (15 of 39) of the deaths. Fifty-three percent of the feline cases were bubonic, but only 41% (16 of 39) of the deaths were bubonic.

Table 2—Survival of cats with plague by type of plague and use of antibiotic treatment (n = 119)

Treated/type plague	Survived	Died	Euthanatized	Total
Treated with antibiotics				
Bubonic	41	1	4	46
Septicemic or Unclassified	26	0	2	28
Pneumonic	3	0	0	3
Total	70	1	6	77
No antibiotic treatment reported				
Bubonic	6	1	10	17
Septicemic or Unclassified	3	7	6	16
Pneumonic	1	5	3	9
Total	10	13	19	42

Most of the 77 cats treated with antibiotics survived, in contrast to the 42 cats not treated with antibiotics. Only one quarter of those survived, with approximately one third dying and almost half euthanatized.

Tetracycline, doxycycline, or vibramycin was used in 43% of those cases for which antibiotics were used, ampicillin, amoxicillin, or hetacillin was used in 16%, penicillin was used in 9%, trimethoprim-sulfadiazine was used in 5%, trimethoprim-sulfamethoxazole was used in 3%, gentamicin was used in 4%, streptomycin was used in 3%, lincomycin was used in 3%, and chloramphenicol was used in 3% of cases. Antibiotic doses, reported in 34 cases, varied widely. For tetracycline, the total daily dose ranged from 50 to 500 mg. Time between start of treatment and recovery was recorded for 20 cats, and ranged from 1 to 10 days, with a mean of 4.4 days.

An antibiotic-treated cat that died had been treated with amoxicillin; treatment for the euthanatized cats included amoxicillin or ampicillin (2 cats), ampicillin and penicillin (1 cat), tetracycline (2 cats), and trimethoprim-sulfadiazine (1 cat). For those cats treated with a single type of antibiotic, the recovery rate was 95% for the tetracyclines. Other antibiotics were used solely for treatment too infrequently to interpret recovery rates accurately.

Clinicopathologic findings—Details regarding confirmatory laboratory test results were still available for 115 cases. Three early cases had been recorded as laboratory-confirmed, but the details on the tests are no longer available. A household with 2 cats with similar signs and onset times only had confirmatory laboratory testing done on 1 of the cats, and the second one was also reported as a case.

Thirty-nine percent (47 of 119) of the cases were confirmed with FA testing alone. Eighteen percent (21 cases) were confirmed with a single titer ≥ 32 after typical plague signs. Culture and FA results were positive for 11% (13) of the cats. Combinations of positive and negative test results were available for 29% (34) of the 119 cases.

Through FA testing or culturing, the *Y pestis* organism was identified in buboes in 42 cases and in blood in 9 cases. Other sites included abscesses (10 cases), spleen (8), lung (7), liver (7), wounds (1), and tongue lesion exudate (1).

Titers were reported for 50 cats, although acute and convalescent titers were available for only 14 of them. The number of days after onset of signs could be estimated for 50 of the serum specimens. The titers ranged from < 1:4 for a serum specimen taken 1 day after reported onset of signs, to 1:8,192 for a specimen taken 1 to 28 days after onset of signs. Follow-up titers were available for 8 cases. At 6 months after illness, 2 cats had titers of 1:16 and 1:32. At 9 months, the titers for 3 cats ranged from 1:256 to 1:2,048. At 1 year, the titers for 3 cats ranged from 1:1,024 to 1:8,192.

Information on WBC counts (WBC/μl) and differentials was available for only 14 cats (Table 3). The WBC counts were lower for more seriously ill cats, as defined by type of plague. A relative neutrophilia was reported for 7 of 11 cats, with a range of 80 to 100% segmented cells. An absolute neutrophilia was reported for 3 of 9 cases, with ranges of 12,600 to 25,344 neutrophils/μl. An increase in band cells was reported for 8 cats, with a range of 640 to 1,989 cells/μl (5 to 13%). Absolute lymphocyte counts were low for 7 cats (450 to 1,260 lymphocytes/μl), and 2 other cats had a relative lymphopenia (11 to 17%). Monocyte concentrations were normal for 9 cats, with reported values of 0 to 576 monocytes/μl (0 to 4%). Eosinophils were also normal for 9 cats, with counts of 0 to 576

Table 3—Reported WBC *and differential counts (*WBC*/µl; n = 14)*

Type of plague	Survival status	WBC	Segmented cells	Band cells	Lymphocytes	Monocytes	Eosinophils
Bubonic	S	28,800	88%	5%	3%	2%	2%
	E	16,000	NIR	NIR	NIR	NIR	NIR
	S	16,000	72%	5%	17%	NIR	4%
	S	15,300	81%	13%	5%	1%	0%
	S	14,000	90%	NIR	9%	1%	*
	S	10,800	74%	14%	9%	2%	1%
	E	NIR	69%	6%	19%	4%	2%
	E	NIR	"neutrophilia"	NIR	NIR	NIR	NIR
Septicemic/ Unclassified	S	14,100	11,280	987	1592	141	NIR
	S	9,700	NIR	"left shift"	NIR	NIR	NIR
	S	9,000	89%	8%	5%	1%	0%
	S	4,200	"all"	0	NIR	NIR	NIR
Pneumonic	S	4,700	62%	2%	25%	NIR	11%
	E	1,320	NIR	NIR	NIR	NIR	NIR

S = survived; E = euthanatized; NIR = no information reported

eosinophils/µl (0 to 4%). Reported PCV values were normal for 4 cats (35 to 44%) and high for 1 cat (54%). Total proteins were normal for 1 cat (7.2) and high for 3 cats (8.4 to 8.9).

Pathologic findings—Necropsies were performed on 11 cats by local veterinarians or by pathologists at New Mexico Veterinary Diagnostic Services. Three of the cats necropsied were classified as having bubonic plague. Typical gross findings for these cats were emaciation, abscess formation (usually involving a lymph node), and abundant subcutaneous edema around the abscess. Microscopic examination of the abscesses revealed dense neutrophil infiltration. Fibrosis was present at the periphery of the abscesses; however, the abscesses were generally poorly encapsulated.

Four of the cats necropsied were classified as having pneumonic plague. The lung lesions tended to be focal, with each lesion being 1 to several centimeters in diameter. Microscopically, there was a dense infiltrate of neutrophils in alveoli and small bronchioles in the affected areas of lung (Fig 2). The borders of the lesions were indistinct. Numerous small coccobacilli were present in alveoli and bronchioles in the affected areas.

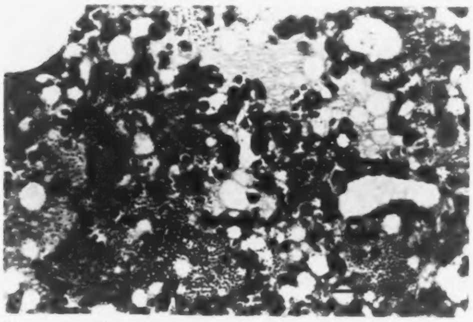

Figure 2—Photomicrograph of lung section from cat with pneumonic plague. Notice neutrophilic infiltrate and many gram negative bipolar staining coccobacilli, confirmed as Yersinia pestis. *Giemsa stain; bar = 20 µm.*

Four cats with neither buboes nor pneumonia (unclassified, presumed septicemic) were necropsied. Lesions were not found in 3 of these cats, 2 that had their signs confirmed as plague with a single high titer before euthanasia, and 1 that was confirmed as having plague by use of fluorescent antibody testing before it died. Interstitial pneumonia and focal necrotizing hepatitis were found in a fourth cat that had died after confirmation of plague infection with fluorescent antibody. However, *Y pestis* organisms were not isolated on necropsy. *Toxoplasma* organisms were present in both the lung and liver lesions, and it was thought that *Toxoplasma*, rather than *Y pestis*, was responsible for those lesions. Use of any antibiotic treatment was not reported for these 4 cases.

Discussion

Because most of the cats with plague in New Mexico had buboes, lethargy, anorexia, and fever, any cat with these signs and that lives in a plague-endemic area or has traveled from such an area should have appropriate plague diagnostic testing, particularly if it is a hunter.[14] In addition, veterinary staff must take care to reduce their own chances of infections through bites, open wound contacts with draining infective material, or inhalation of respiratory aerosols.

Because we have no surveys of the feline population of New Mexico with which to compare the observed signalment of the plague cases, we cannot definitively determine from this study whether age, gender, neutering status, or breed are risk factors for infection. Thus, these factors cannot be used at this time to rule in or rule out cases, but if these factors influence roaming and hunting, they might be expected to be correlated with risk of infection.

Most plague-related buboes will be submandibular or cervical and bilateral. However, lymphadenopathy can develop in other nodes, and in other nodes it will usually be unilateral. We believe that submandibular or cervical nodes become infected after oral inoculation of the organism through ingestion of infected rodents. Other lymph nodes probably enlarge after a flea bite in the area drained by the node. Although some of the buboes were abscessed at the time of diagnosis, most were not draining prior to veterinary intervention.

Cats with abscesses, lethargy, anorexia, and fever could have plague or cat bite abscesses, and a history of fighting with other cats or visible puncture wounds may help in the differential diagnosis.

Hunting cats from plague-endemic areas and that have pneumonia require the quickest response, because plague-infected aerosol could result in a large number of human primary pneumonic infections. In cats and human beings, pneumonic infections are difficult to treat successfully. Fortunately, pneumonic cases were only a small fraction of plague cases in cats.

Plague cases in cats with neither buboes nor pneumonia are probably missed most often, because the signs of fever, lethargy, and anorexia are consistent with many viral or bacterial infections. Cats infected with septicemic plague may have oral or gingival ulcerations, dyspnea, coughing, and sneezing similar to those attributable to the common calici and herpes viruses. It is not understood why people or cats with septicemic plague never develop palpable buboes.

Tularemia *(Francisella tularensis)* must also be differentiated from plague in cats with hunting histories. Both infections elicit a severe febrile reaction, and can become septicemic or pneumonic.[18] The geographic distribution of the 2 diseases overlaps (although tularemia is more widespread in the United States).[18] In the western United States, both diseases are more frequent in the warmer months.[19] However, few feline tularemia cases have been reported in New Mexico, so plague remains a more likely cause of clinical signs common to both diseases in this area.

Even in New Mexico, cats with these signs more often have diseases other than plague or tularemia. For example, of 117 FA tests completed for feline plague by our Scientific Laboratory Division in 1988, only 18 were positive for plague, and none were positive for tularemia. Of 137 cultures done, only 8 were plague-positive, and of 82 serologic analyses done, only 3 yielded a fourfold increase in titer, and only 2 were high single titers.

A suspect case of feline plague can be confirmed quickly with laboratory testing. Veterinarians can look for bipolar-staining, gram-negative coccobacilli on lymph node aspirates with Wayson or Giemsa stain,[10] but this is merely suggestive evidence. Lymph node or abscess aspirates should be tested with FA staining, the most sensitive and specific rapid diagnostic test.

Our data indicates that FA test results can be negative (possibly because of missing the organisms in the lymph node tap) and thus culturing and serologic analysis should also be considered for suspect cases. Organisms may be cultured from lymph node or abscess aspirates, tracheal washes, and blood, but results may not be available for up to 4 days. Septicemic plague is particularly difficult to define and confirm, and culturing of blood should be done.

A maximal increase in titers of 1:2,048 by day 12 has been observed in cats experimentally infected with *Y pestis*.[20] For naturally acquired infections in New Mexico, titers varied considerably even within 1 day of reported onset of signs. Owners of cats with plague frequently report their cats disappearing for several days before returning ill, so estimates of date of onset of signs are subject to error. However, on the basis of our data, cats are capable of generating an intense immune response to plague infection within days of exposure. Although it is difficult to determine time of exposure for naturally acquired plague in cats, cats with experimentally induced infections became ill within 24 to 48 hours of exposure.[20]

The duration of high antibody titer to the *Y pestis* antigen in naturally infected cats is unknown. In New Mexico cases, titers for some cats were low months after infection, whereas for others, the titers were as high as 1:8,192 a year after infection. These high titers could be related to subclinical reinfection in cats that continue to hunt and become exposed. In an experimental trial, by day 30, antibody titers decreased to a steady plateau of 1:512, which persisted through day 300.[20]

When a cat has signs suggestive of plague, a single titer ≥ 1:32 is usually considered diagnostic, but could indicate a previous rather than current infection. To our knowledge, serosurveys of nonill cats have not yet been done in New Mexico to ascertain the frequency of infection. A single titer lower than 1:32 taken during the first several days of clinical signs may not rule out plague because the immune system in some cats has not yet had time to respond. A fourfold increase in titers taken at least 2 weeks apart confirms concurrent plague infection.

An absolute neutrophilia with a left shift has been observed by other authors in cats with plague.[11] The WBC counts and differential counts were not reported for most of New Mexico's plague cases in cats. For those reporting, a relative neutrophilia with a left shift and lymphopenia was most frequently observed.

The lesions found in the 11 cats necropsied were similar to those previously described in experimentally infected[20] and naturally infected[11] cats. In the bubonic and pneumonic cases, the lesions tended to be focal, suppurative, and poorly defined. Numerous small bacteria could generally be found in the lesions. Cats with the septicemic form of plague typically had no gross or microscopic lesions that could be attributed to the plague organism.

Because of high mortality, potential cat-to-human being and cat-to-cat transmission, cats suspected of having plague are usually treated with antibiotics presumptively until laboratory confirmation is available. Studies of antibiotic effectiveness against plague organisms have been performed primarily in vitro and in human beings, not in cats. Thus we have recommended and New Mexico veterinarians have used the same antibiotics for feline cases as those recommended for human cases.

Although the higher survival rate in those cats with plague that are treated with antibiotics offers support for a causal association between antibiotic treatment and recovery, an alternative explanation is the opposite causal association, that is, those cats more likely to recover (such as those with bubonic plague) were more likely to be given antibiotics. On the basis of data for the New Mexico cases, both phenomena were occurring. However, even in the cats with more serious signs, there was a higher survival rate with antibiotic treatment, as indicated by the fact that all of the cats with pneumonic plague and that were treated with antibiotics survived.

Tetracyclines appear to be the most effective antiobiotics in uncomplicated cases and for plague-infected cats without clinical signs.[8] We have recommended oral administration of tetracycline to cats with such cases at a rate of 25 mg/kg of body weight, q 8 h.[21] In human cases, chloramphenicol and aminoglycosides such as streptomycin and gentamicin are believed to be more effective in severe infections,[8] and were used successfully in some of the cats in New Mexico. Trimethoprim-sulfamethoxazole is used frequently to treat children with plague, and was also used successfully in a few cats with plague in New Mexico. Antibiotics in the penicillin and ampicillin families have not been shown to be efficacious in vitro, and our observed lower recovery rate with ampicillin supports this. The 3 cats treated with penicillin alone survived; however, this is a small number of cats and they probably would have recovered without antibiotic treatment.

It is not known whether the recent increase in plague cases in cats in New Mexico is a result of higher incidence of infection, improved surveillance, or increased awareness on the part of veterinarians. The incidence of plague in human beings appears to follow a 5-year cycle, possibly related to epizootics in host rodents with high mortality.[a] The seasonal distribution of plague in cats and human beings reflects the reduced activity in the winter of rodents, rodent fleas, human beings, and their pets. Dog and cat fleas do not appear to be involved in plague transmission, and are uncommon in plague endemic areas in New Mexico.

Prevention of plague infection is important because diagnosis in time for effective treatment of plague-infected cats and human contacts is often difficult. To reduce the risk of being infected with plague and transporting plague-infected fleas into the home environment, owners who live in plague-endemic areas should consider dusting their cats with flea powder weekly (especially during the summer months), preventing their cats from hunting, and eliminating rodent harborage such as wood piles, junk piles, or garbage.

Veterinarians and their staffs can reduce their risk of acquiring plague by treating cats for fleas as soon as plague is suspected, isolating cats with suspect plague to prevent human and cat contact with draining abscesses and pneumonic aerosols, and using mask and gloves when handling live or dead cats suspected to have plague. Specimens should be submitted as soon as possible to a qualified laboratory to have plague confirmed, so that contacts can be evaluated for antibiotic prophylaxis.

Additional studies are necessary to investigate the geographic and temporal risks of acquiring plague infections. Serologic studies in dogs[22-24] are useful because their infection is usually subclinical and self-limiting.[8,20,24,25] In addition, there should be further investigation with experimental studies of the feline subclinical and case fatality rates. Better documentation of septicemic plague in cats is needed by submission of blood for cultures, and more deceased euthanatized cats should be submitted for necropsy and histologic analyses. Finally, better definition of potential risk factors would be useful, including lack of neutering, rodent and flea exposure a week before illness onset, and lack of flea control.

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Book Review: Swine Nutrition Guide

This paperback is a useful, inexpensive introduction to applied swine nutrition. The text is easily understood and includes reliable information about criteria that influence feedstuff selection and diet composition. Special attention has been paid to the use of major Western feedstuffs in swine nutrition.

Two very informative chapters cover the nutrient requirements of pigs and discuss the potential use of a wide variety of feedstuffs in swine rations. Four other chapters address feeding regimens and diet composition for pigs in various production stages. The text includes tables with sample diets for each production group and discusses the various factors that affect feed intake and use. Other sections cover methods of diet formulation, feed processing techniques, and toxin contamination of feed.

This text will be a valuable source of information for students, veterinary practioners, and managers of swine operations who wish to acquire a basic understanding of swine nutrition. Selected references at the end of each chapter direct the reader to more specific and detailed information. The text lacks concise, complete summaries in regard to the intended audience. Several chapters present information in discussion form; other sections highlight important information in numerous small windows. The use of the text for self-instruction or as a quick reference is hampered by this approach. The authors should consider the introduction of summary charts that group and contrast essential information of whole chapters or related topics. —*[Swine Nutrition Guide. By John Patience and Phil Thacker. 260 pages; illustrated. Saskatchewan, Saskatoon. Canada S7N OWO 1989. Price $21.50; in USA $22.00.]*—ANTON L. PRESSING

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ONLY THE FOLLOWING PAGES OF THIS

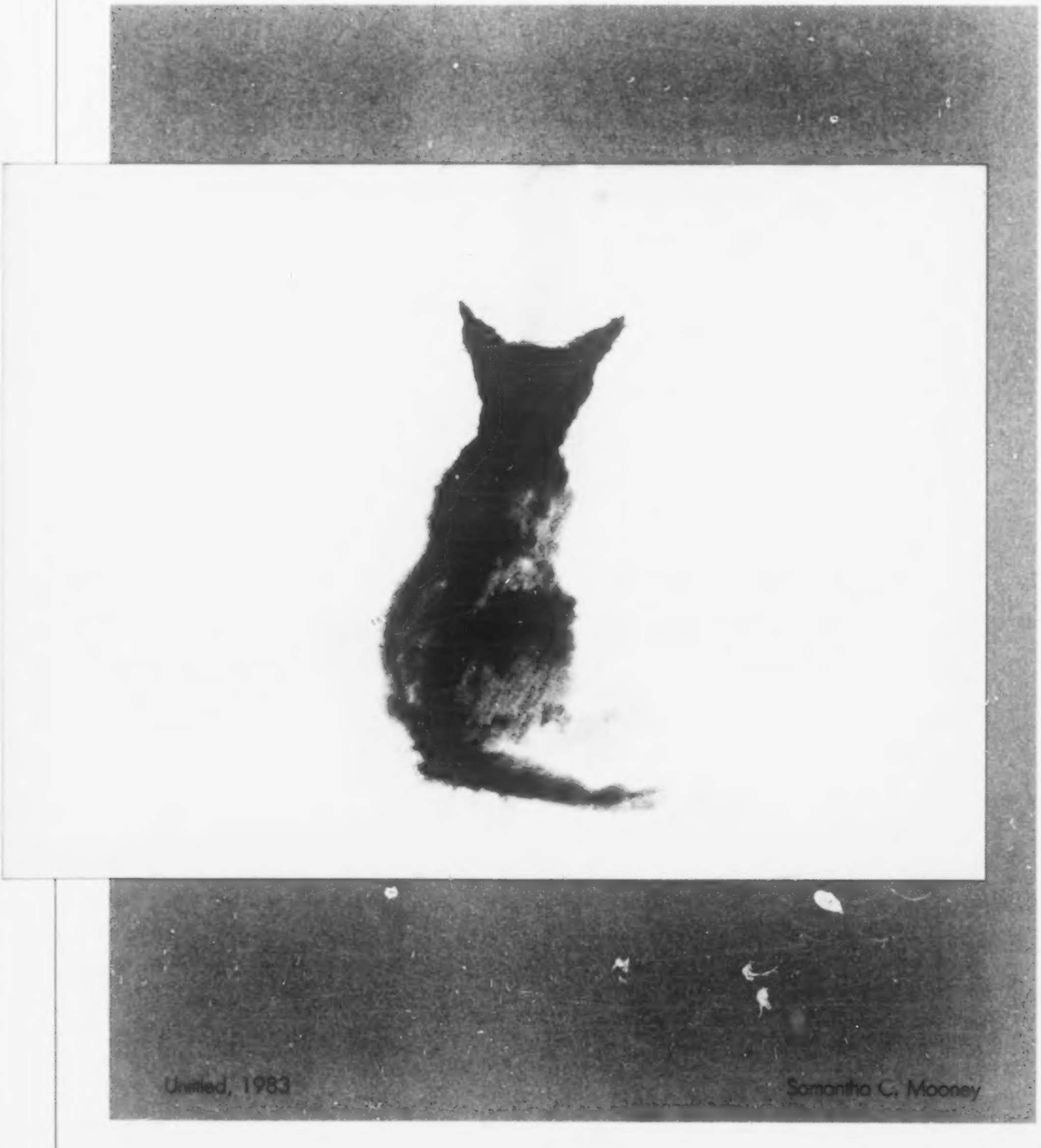
PUBLICATION HAVE BEEN FILMED

Cov. 1, Pgs: 1234-1236,

1348-1353, 1365-1373

November 15, 1991, Volume 199, Number 10

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION



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JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 199 November 15, 1991 No. 10
JAVMA 199 (10) 1233-1520
ISSN 0003-1488

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SUBSCRIPTIONS: For one year: members $35; others $70 in the United States and possessions, $90 in foreign countries. Single copies: $6.00 in the United States and possessions, $8.00 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1991 by the AVMA.

ADDRESS CHANGE: Send new address (and moving date) 45 days ahead. Include old address as it appeared on previous issues (if possible send label).

POSTMASTER: Send address changes to JAVMA, 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360.

BPA

Report of the National FeLV/FIV Awareness Project

Thomas P. O'Connor, Jr, PhD; Quentin J. Tonelli, PhD; Janet M. Scarlett, DVM, PhD

The FeLV and the feline immunodeficiency virus (FIV) are the 2 most common pathogenic retroviruses reported in feline populations. Although the viruses induce disease manifestations that are clinically indistinguishable, the physical properties of the viral particles are clearly distinct.[1] The FeLV was initially described by Jarrett et al[2] in 1964 and has been classified in the Oncornaviridae subfamily of retroviruses. In addition to the oncogenic potential of the virus, FeLV infection can result in a number of degenerative and immunosuppressive disorders, including chronic gingivitis, stomatitis, oral ulcers and chronic respiratory tract disease.[3] The FIV was initially identified and isolated by Pedersen et al[4] in 1986 and has been classified in the retroviral subfamily Lentiviridae. The primary disease syndrome induced by FIV infection also is degenerative and immunosuppressive in nature and includes chronic infections of the mouth, nasal passages, and intestinal tract; lymphadenopathy; and fever.[5]

The generation of polyclonal antibodies to FeLV, and monoclonal antibodies specific for the group-associated antigen of FeLV led to the development of specific immunoassays for the detection of FeLV antigen.[2-6] The continuous propagation of FIV in an established feline cell line and the purification of FIV from cell culture led to the development of immunoassays for the detection of antibody to FIV.[4,7] Enzyme-linked immunosorbent assays, initially developed separately for the detection of FeLV antigen (Ag) and FIV antibody (Ab), were subsequently combined to construct an assay for simultaneous detection of FeLV Ag and/or FIV Ab.[a]

The purpose of the National FeLV/FIV Awareness Project was to determine the nationwide distribution of the viruses among cats with clinical signs of disease (hereafter referred to as symptomatic) and high-risk cats, to learn more about regional prevalence in symptomatic and high-risk cats, and to expand the understanding of the epidemiology of FeLV and FIV infections. Symptomatic and high-risk cats were included in the study because these groups would more likely be examined by veterinary practitioners for possible infection. We herein report a serologic survey of 27,976 cats from all 50 states of the United States. Individual veterinary practitioners tested cats that they considered to be symptomatic or at high risk for infection, using the combination FeLV Ag/FIV Ab test. In addition to assay results, pertinent data were requested on a survey form that included health status, gender, age, breed, environment, number of household cats, and categorization of clinical signs of disease.

Materials and Methods

FeLV Ag/FIV Ab ELISA method—The combination FeLV Ag/FIV Ab ELISA can be performed using serum, plasma or blood. The assay procedure was included in the package insert supplied with each test kit.

The sensitivity and specificity of the combination FeLV Ag/FIV Ab ELISA were initially evaluated by testing samples from a population of experimentally infected cats and samples obtained from cats in a field setting (n = 324). Samples were analyzed using a licensed FeLV Ag microtitration plate test[b] and a licensed FIV Ab microtitration plate test.[c] Samples positive for FeLV Ag were confirmed by use of antibody neutralization assays, and FIV Ab-positive samples were confirmed positive by use of western blot and sodium dodecyl sulfate radioimmunoprecipitation assays. Test sensitivity was 100% for FeLV Ag and 98.3% for FIV Ab. The FIV Ab confirmatory assays were validated using samples with known positive or negative results.[7] The overall test specificity was 100% for FeLV Ag and for FIV Ab.

From IDEXX Laboratories, Inc, 100 Fore St, Portland, ME 04101 (O'Connor, Tonelli), and the Department of Clinical Sciences, New York State College of Veterinary Medicine, Cornell University, Ithaca, NY 14853 (Scarlett).

Dr. O'Connor's present address is IDEXX Laboratories Inc, One IDEXX Drive, Westbrook, ME 04092.

[a] CITE Combo FeLV Ag/FIV Ab, IDEXX Laboratories Inc, Westbrook, Me.

[b] PetChek FeLV Ag test kit, IDEXX Laboratories Inc, Westbrook, Me.

[c] PetChek FIV Ab test kit, IDEXX Laboratories Inc, Westbrook, Me.

Table 1—Prevalence of FeLV and feline immunodeficiency virus (FIV) seropositivity by state

State	Total	No. FeLV Ag-positive (%)	No. FIV Ab-positive (%)	No. FeLV Ag-and FIV Ab-positive (%)
AK	72	7 (9.7)	3 (4.2)	0 (0.0)
AL	415	60 (14.5)	26 (6.3)	5 (1.2)
AR	58	7 (12.1)	6 (10.3)	0 (0.0)
AZ	534	86 (16.1)	39 (7.3)	14 (2.6)
CA	3,427	353 (10.3)	190 (5.5)	23 (0.7)
CO	358	54 (15.1)	33 (9.2)	10 (2.8)
CT	375	32 (8.5)	22 (5.9)	5 (1.3)
DE	20	3 (15.0)	2 (10.0)	1 (5.0)
FL	2,643	339 (12.8)	223 (8.4)	53 (2.0)
GA	618	89 (14.4)	43 (7.0)	5 (0.8)
HI	158	16 (10.1)	25 (15.8)	1 (0.6)
IA	161	29 (18.0)	8 (5.0)	2 (1.2)
ID	61	11 (18.0)	5 (8.2)	1 (1.6)
IL	931	95 (10.2)	72 (7.7)	14 (1.5)
IN	627	93 (14.8)	57 (9.1)	19 (3.0)
KS	345	43 (12.5)	29 (8.4)	5 (1.4)
KY	291	38 (13.1)	18 (6.2)	3 (1.0)
LA	205	39 (19.0)	28 (13.7)	6 (2.9)
MA	957	124 (13.0)	82 (8.6)	11 (1.1)
MD	213	22 (10.3)	13 (6.1)	2 (0.9)
ME	529	71 (13.4)	43 (8.1)	8 (1.5)
MI	1,095	125 (11.4)	65 (5.9)	14 (1.3)
MN	262	25 (9.5)	7 (2.7)	0 (0.0)
MO	288	43 (14.9)	21 (7.3)	2 (0.7)
MS	144	20 (13.9)	13 (9.0)	0 (0.0)
MT	59	3 (5.1)	2 (3.4)	1 (1.7)
NC	843	165 (19.6)	71 (8.4)	18 (2.1)
ND	24	2 (8.3)	1 (4.2)	0 (0.0)
NE	113	22 (19.5)	10 (8.8)	2 (1.8)
NH	271	39 (14.4)	31 (11.4)	6 (2.2)
NJ	473	71 (15.0)	35 (7.4)	10 (2.1)
NM	168	17 (10.1)	8 (4.8)	0 (0.0)
NV	89	9 (10.1)	2 (2.2)	0 (0.0)
NY	1,652	227 (13.7)	119 (7.2)	21 (1.3)
OH	1,456	161 (11.1)	86 (5.9)	19 (1.3)
OK	135	30 (22.2)	18 (13.3)	3 (2.2)
OR	945	143 (15.1)	72 (7.6)	15 (1.6)
PA	617	146 (23.7)	60 (9.7)	12 (1.9)
RI	50	4 (8.0)	9 (18.0)	0 (0.0)
SC	134	23 (17.2)	15 (11.2)	3 (2.2)
SD	25	5 (20.0)	6 (24.0)	2 (8.0)
TN	296	49 (16.6)	30 (10.1)	5 (1.7)
TX	2,330	318 (13.6)	211 (9.1)	51 (2.2)
UT	134	14 (10.4)	9 (6.7)	0 (0.0)
VA	805	103 (12.8)	33 (4.1)	8 (1.0)
VT	146	21 (14.4)	7 (4.8)	3 (2.1)
WA	1,194	178 (14.9)	101 (8.5)	28 (2.3)
WI	583	62 (10.6)	28 (4.8)	3 (0.5)
WV	62	17 (27.4)	8 (12.9)	2 (3.2)
WY	96	15 (15.6)	8 (8.3)	3 (3.1)
*	489	44 (9.0)	26 (5.3)	3 (0.6)
Total	27,976	3,712 (13.3)	2,079 (7.4)	422 (1.5)

Cats seropositive for both viruses were included in the FeLV Ag and FIV Ab summations.

Data for the state of Virginia include Washington DC. *State information not provided.

Design of project—Veterinary practitioners and clinics were informed of the project by a direct mail campaign to 12,500 veterinarians, and by veterinary distributor representatives throughout the United States. Participating practitioners purchased test kits, were given information about the project, and were asked to complete an epidemiologic survey form. Each practitioner was asked to identify, test, and report results for only symptomatic and high-risk cats. Signs suggestive of FeLV or FIV infection were not specified. High-risk cats were described as outdoor cats, cats exposed to outdoor cats, and cats in large multicat households with frequent introduction of new cats.

Table 2—Regional comparison of FeLV and FIV seropositivity

Region	Total	No. FeLV Ag-positive (%)	No. FIV Ab-positive (%)	No. FeLV Ag/ FIV Ab-positive (%)
Northwest (WA, OR, MT, ID, WY, AK)	2,427	357 (14.7)	191 (7.9)	48 (2.0)
Southwest (CA, NV, UT, AZ, CO, HI)	4,700	532 (11.3)	298 (6.3)	48 (1.0)
South Central (NM, TX, OK, AR, LA)	2,896	411 (14.2)	271 (9.4)	60 (2.1)
Midwest (ND, SD, NE, KS, MN, IA, MO)	1,218	169 (13.9)	82 (6.7)	13 (1.0)
Lakes (WI, IL, IN, MI, OH)	4,692	536 (11.4)	308 (6.6)	69 (1.5)
East (PA, MD, NJ, DE, NY)	2,975	469 (15.8)	229 (7.7)	46 (1.5)
Northeast (ME, NH, VT, MA, RI, CT)	2,328	291 (12.5)	194 (8.3)	33 (1.4)
Midatlantic (WV, VA, KY, NC, TN)	2,297	372 (16.1)	160 (7.0)	36 (1.6)
South (MS, AL, GA, SC, FL)	3,954	531 (13.4)	320 (8.1)	66 (1.7)
*Other	489	44 (9.0)	26 (5.3)	3 (0.6)
Total	27,976	3,712 (13.3)	2,079 (7.4)	422 (1.5)

*State information not provided.

Information requested for each cat included test results, gender, breed, age, number of cats in household, environment of the cat (indoor, outdoor, or both), health status (symptomatic or asymptomatic [not manifesting clinical signs of disease]) and presence of specified clinical signs of disease. The specified clinical signs of disease were fever, weight loss, abscesses, diarrhea, swollen lymph nodes, dermatitis, oral infections, rhinitis, conjunctivitis, dehydration, urinary tract infection and neurologic abnormalities. A total of 1,558 veterinarians responded to the survey. Completed survey forms were returned, and results were compiled.

Statistical methods—Comparisons of the prevalence of infection of FeLV and/or FIV among subgroups of the population were made using a χ^2 test of independence. Probability value <0.01 was considered statistically significant.

Results

National distribution of FeLV Ag- and FIV Ab-positive results— The survey involved 27,976 domestic cats from across the United States that were considered by veterinary practitioners to be symptomatic or to be at risk for FeLV or FIV infection. In the overall study population, 13.3% were positive for FeLV Ag, 7.4% were positive for FIV Ab, and 1.5% were positive for both viruses. The prevalence of FeLV Ag and FIV Ab in the symptomatic/at-risk population was calculated in a state-by-state fashion, and was found to be fairly uniform throughout the nation (Table 1). The states were subse-

Table 3—Basic features of population

Category	Total No.	No. FeLV Ag-positive (%)	No. FIV Ab-positive (%)	No. FeLV Ag- and FIV Ab-positive (%)*
Health status†				
Asymptomatic, at risk	15,374	1,049 (6.8)	619 (4.0)	82 (0.5)
Symptomatic	12,602	2,663 (21.1)	1,460 (11.6)	340 (2.6)
Gender				
Female	12,517	1,391 (11.1)	445 (3.6)	86 (0.7)
Male	15,459	2,321 (15.0)	1,634 (10.6)	336 (2.2)
Age (yr)				
<1	9,715	620 (6.4)	144 (1.5)	19 (0.20)
1 to 3	8,656	1,581 (18.3)	609 (7.0)	157 (1.8)
4 to 6	3,331	608 (18.3)	420 (12.6)	99 (3.0)
>6	4,171	559 (13.4)	686 (16.4)	103 (2.5)
Age not reported	2,103	344 (16.3)	220 (10.5)	44 (2.1)
Environment				
Indoor	5,588	419 (7.5)	150 (2.7)	26 (0.5)
Outdoor	2,640	539 (20.4)	341 (12.9)	74 (2.8)
Both	12,470	1,933 (15.5)	1,125 (9.0)	231 (1.9)
Unknown	7,278	821 (11.3)	463 (6.4)	91 (1.2)
Breed				
Domestic	18,736	2,468 (13.2)	1,368 (7.4)	283 (1.5)
Mixed breed/unknown	7,143	1,032 (14.4)	595 (8.3)	115 (1.6)
Purebreed	2,097	212 (10.1)	96 (4.6)	24 (1.1)
Total population	27,976	3,712 (13.3)	2,079 (7.4)	422 (1.5)

*Cats seropositive for both viruses were included in the FeLV Ag and FIV Ab summations. †Asymptomatic = cats not manifesting signs of disease. symptomatic = cats manifesting signs of disease.

Table 4—Comparison of FeLV Ag-, FIV Ab- and FeLV Ag/FIV Ab-positive cats

Category	Overall population	FeLV Ag-positive	FIV Ab-positive	FeLV Ag/FIV Ab-positive
Health status				
Ratio of symptomatic, at-risk to asymptomatic	0.82:1	2.5:1	2.3:1	4.1:1
Gender				
Ratio of male to female	1.2:1	1.7:1	3.7:1	3.9:1
Environment				
Ratio of outdoor to indoor	0.5:1	1.2:1	2.1:1	2.8:1
Mean age (yr)	2.5	2.9	5.2	4.25

See Table 3 for key.

Table 5—Infection rate in multicat households

No. of household cats	Total No.	No. FeLV Ag-positive (%)	No. FIV Ag-positive (%)	No. FeLV Ag/FIV Ab-positive (%)
1	12,194	1489 (12.2)	910 (7.5)	170 (1.4)
2 to 5	12,240	1648 (13.5)	852 (7.0)	181 (1.5)
>6	2,272	366 (16.1)	225 (9.9)	48 (2.1)
Not specified	1,270	209 (16.4)	92 (7.2)	23 (1.8)

quently grouped into regions, and seroprevalence was determined for various regions of the country (Table 2). Although the regional seropositive rate differences were small, some were found to be significant ($P < 0.01$).

Epidemiologic features of the population—A total of 12,602 cats (45.0%) was categorized as symptomatic and of these, 2,663 (21.1%) were FeLV Ag-positive and 1,460 (11.6%) were FIV Ab positive (Tables 3 and 4). The seropositive rates for cats categorized as asymptomatic/at-risk were 6.8% (FeLV Ag) and 4.0% (FIV Ab). The ratio of cats categorized as symptomatic to cats categorized as asymptomatic/at-risk was slightly higher for FeLV Ag-positive cats (2.4:1), compared with FIV Ab-positive cats (2.1:1).

In the overall symptomatic/at-risk population of cats were 12,517 females and 15,459 males (male to female ratio, 1.2:1). A total of 11.1% of the females and 15.0% of the males were FeLV Ag-positive, whereas 3.6% of the females and 10.6% of the males were FIV Ab-positive. Male-to-female ratio for seropositive cats was 1.7:1 (FeLV Ag) and 3.7:1 (FIV Ab). Ages of the FeLV Ag- and the FIV Ab-positive cats ranged from 1 month to >15 years. The prevalence of FeLV infection was essentially the same for cats in the age groups 1 to 3 years and 4 to 6 years, and was significantly ($P < 0.01$) reduced in the groups of cats <1 year old or >6 years old. In contrast, the prevalence of FIV and FIV/FeLV infection was significantly ($P < 0.01$, χ^2 test of trend) increased with age. Mean age of the overall study population was 2.5 years; mean age of the seropositive populations was 2.9 (FeLV Ag) and 5.2 (FIV Ab) years. Mean age of the seropositive symptomatic cats was greater than mean age of the seropositive asymptomatic cats. This difference was 1.3 years for FeLV Ag-positive cats and 1.8 years for FIV Ab-positive cats.

Seroprevalence for FeLV Ag and FIV Ab was significantly ($P < 0.01$) lower for indoor cats, compared with outdoor cats. Cats that were classified as both (indoor and outdoor) or as unknown had seroprevalence that was between that of the strictly outdoor and strictly indoor categories. Domestic and mixed-breed cats had essentially the same seroprevalence, which was significantly ($P < 0.01$) higher than the comparable value for purebred cats.

Seroprevalence was determined for each virus in groups of cats selected according to the number of household cats living in the same domain as the cat initially submitted for testing. The FeLV Ag seropositive rate increased as the number of cats in the household increased (Table 5). The FeLV Ag and FIV Ab-seropositive rates were significantly ($P < 0.01$) higher in cats from households with more than 6 cats, compared with households with either 1 or 2 to 5 cats.

A total of 422 cats (1.5% of the overall study population) was found to be infected with both viruses. These cats were more likely to be clinically ill, more likely to be male, and more likely to be outdoor cats than were cats infected by either virus alone. In addition, cats positive for FeLV Ag were more likely to be FIV Ab-positive than were FeLV Ag-negative cats. Among the 3,712 cats that were positive for FeLV Ag, 422 (11.4%) were positive for FIV Ab. This rate was significantly ($P < 0.01$) higher than the FIV Ab seroprevalence of 6.8% found for the FeLV Ag-negative population

Table 6—Sexually intact vs neutered cats

Gender	Total No.	No. FeLV Ag-positive (%)	No. FIV Ab-positive (%)
Female (sexually intact)	7,274	726 (10.0)	136 (2.7)
Female (neutered)	5,243	665 (12.7)	249 (4.7)
Male (sexually intact)	8,423	1,203 (14.3)	684 (8.1)
Male (neutered)	7,036	1,118 (15.9)	950 (13.5)

Table 7—Rate of FIV Ab-positivity in low-risk populations

Low-risk groups	No.	No. FIV Ab-positive (%)
Asymptomatic, indoor only, single cat household	1,450	21 (1.4)
Group 1/sexually intact	1,057	9 (0.85)
Group 1/<2 years old	955	7 (0.73)

*Table 8—Clinical signs of disease in FeLV Ag-, FIV Ab- and FeLV Ag/FIV Ab-positive cats**

Description	No. FeLV Ag-positive (%)	No. FIV Ab-positive (%)	No. FeLV Ag/FIV Ab-Positive (%)
No. of symptomatic cats with disease history	1,574	777	249
Weight loss	996 (63.3)	394 (51.0)	173 (69.4)
Fever	660 (41.9)	281 (36.2)	107 (43.0)
Dehydration	555 (35.2)	162 (21.0)	115 (46.1)
Rhinitis	279 (17.7)	151 (19.4)	56 (22.5)
Diarrhea	271 (17.2)	87 (11.2)	35 (14.1)
Conjunctivitis	271 (17.2)	148 (19.0)	47 (18.9)
Oral infections	238 (15.1)	208 (26.8)	63 (25.3)
Swollen lymph nodes	202 (12.8)	79 (10.2)	31 (12.4)
Abscesses	186 (11.8)	126 (16.2)	33 (13.3)
Signs of neurologic dysfunction	80 (5.1)	36 (4.6)	18 (7.2)
Dermatitis	67 (4.3)	95 (12.2)	20 (8.0)
Urinary tract infection	63 (4.0)	38 (4.9)	6 (2.4)

*Total No. of symptomatic cats with adequate clinical history was 8,317.
See Table 3 for key.

(n = 24,264). Cats that were FeLV Ag-positive were 1.7 times more likely to be FIV Ab-positive than were FeLV Ag-negative cats.

Prevalence of infection for sexually intact and neutered cats was determined (Table 6). Seropositive rates for FeLV Ag and FIV Ab were greater for neutered females and neutered males compared with their sexually intact counterparts. Mean age of the neutered cats (female and male combined) was compared with mean age of the sexually intact cats (female and male combined) for FeLV Ag- and FIV Ab-positive cats. Mean age of the FeLV Ag-positive neutered and sexually intact cats was 4.2 and 1.9 years, respectively. Mean age of the FIV Ab-positive neutered and sexually intact cats was 6.5 and 3.3 years, respectively. Prevalence of FIV Ab was found for several groups of cats predicted to be at lower risk for infection. A total of 21 FIV Ab-positive results (1.4%) were reported for the 1,450 cats in the low-risk group comprising asymptomatic, indoor only, single cat household animals (Table 7). This population was further divided to give 2 additional groups predicted to be at lower risk. The first consisted of 1,057 cats and contained only sexually intact cats (female and male) from the aforementioned population. The second subgroup was made up of 955 cats, <2 years old, from the same population. Nine (.85%) of the sexually intact cats and 7 (0.73%) of the cats <2 years old were positive for FIV Ab.

The frequency of specified clinical signs of disease was determined in descending order of frequency of FeLV-positive cats (Table 8). Among the 12,602 symptomatic cats, 8,317 were reported with the clinical history section of the survey form completed. Of this group, 1,574 (18.9%) were infected with FeLV alone, 777 (9.3%) were infected with FIV alone, and 249 (3.0%) were infected with both retroviruses. Among the FeLV-infected cats, weight loss (63.3%), fever (41.9%) and dehydration (35.2%) were observed most frequently. Weight loss (51.0%), fever (36.2%) and oral cavity infections (26.7%) were the most commonly reported signs of disease for FIV-infected cats. Oral cavity infections were observed in substantially greater number of the FIV- (26.7%) and co-infected (25.3%) cats than in FeLV-infected (15.1%) cats. Rhinitis, conjunctivitis, swollen lymph nodes, and abscesses were each reported in approximately the same percentage for FIV-, FeLV-, and FIV/FeLV-infected cats.

Discussion

Prevalence of FeLV Ag and FIV Ab positives was measured in high-risk asymptomatic and symptomatic feline populations throughout the United States to find and compare the rates of infection in all major regions of the country. Both viruses were found to be prevalent in feline populations throughout the country. Although small state and regional differences in seroprevalence were found, it is difficult to ascertain whether these reflect actual differences in the extent of viral infection or are a consequence of unrelated factors.

Prevalence of FIV infection in the 15,374 high-risk asymptomatic and 12,602 symptomatic cats was 4.0 and 11.6%, respectively. In a recent similar serosurvey, using low or unknown risk asymptomatic (n = 511) and symptomatic cats (n = 2,254) from the continental United States and Canada, infection rates were 1.2 and 14%, respectively.[8] Seroprevalence for the 2 symptomatic cat populations was similar. The higher seroprevalence in the asymptomatic population reported in our study most likely reflects differences in the 2 asymptomatic feline populations. In the previously reported survey, asymptomatic cats without additional risk factors or with unknown risk factors were tested, whereas in our study, the asymptomatic population contained cats principally with specified risk factors for FIV infection. The seroprevalence of FIV Ab, recently reported from several countries for asymptomatic and symptomatic cats respectively, was 6 and 19% (United Kingdom), and 12.4 and 43.9% (Japan).[9,10] The significantly higher rates found for Japanese cats is thought to reflect the high density of cats in Japan and their free-roaming lifestyle.[10]

Results of this serosurvey generally confirm many of the epidemiologic observations made in previous surveys of FIV Ab.[8-10] These include the increased infection rate found in male cats, compared with female cats, and the increased rate of infection for outdoor cats, compared with indoor cats. Both observations reflect the increased tendency of outdoor, male cats to be involved in behaviors that include biting. The FIV has been isolated from the saliva of infected cats, and saliva-mediated transmission of the virus through biting has been implicated as a major mode of infection.[8] The increased prevalence of FIV infection in older cats has been reported.[8,9] This does not appear to reflect age-related susceptibility to infection, but is a consequence of the extended latent period after exposure to the virus which has been observed in cats experimentally infected with FIV.[11] The period of apparent viral latency is typical of lentiviral infections and frequently precedes development of clinical abnormalities.[12] The increased prevalence of FIV infection in households with more than 6 cats reflects the greater contact of these cats with a large number of cats. Similar results have been reported.[9]

Prevalence of FeLV infection found in the high-risk asymptomatic and symptomatic cats was 6.8 and 21.1%, respectively. Similar seropositive rates have been reported in surveys conducted using the ELISA method.[9] A recent serosurvey conducted in the United States found seropositive rates of 3.6 and 11.5% for healthy (n = 361) and sick cats (n = 226), respectively.[13] The lower prevalence of infection in that study most likely reflects differences in survey populations. In that study, healthy cats had no known risk factors for FeLV infection and sick cats were not selected on the basis of signs suggesting disease. In our study, the population consisted principally of asymptomatic cats, selected on the basis of specified risk factors for FeLV and FIV infection, and of symptomatic cats selected on the basis of signs of disease.

In this survey, the ratio of symptomatic to asymptomatic FeLV-positive cats, the age distribution of infected cats, and the ratio of infected males to infected females were similar to reported results.[9,13] A greater percentage of outdoor cats (20.4%) than indoor cats (7.5%) was found to be infected with FeLV. The rate of FeLV infection also increased as the number of cats in the household of the test cat increased, and likely was a result of greater degree of contact of these cats with a number of different cats. Decreased prevalence of FeLV and FIV infection in purebred cats, compared with mixed-breed or domestic cats, has been reported in several studies.[8,9] This is not thought to be attributable to genetic factors, but rather is a reflection of the lifestyles of such cats. Purebred cats are more likely to be housed indoors and are less likely to have contact with seropositive cats.

Prevalence of FIV infection in the 3,712 FeLV Ag-positive cats in the overall survey was 11.4%. Frequency of FIV infection in the FeLV Ag-negative population was 6.8%. Increased prevalence of dual infection in these cats may reflect increased tendency of this group of cats to engage in behavior that would transmit FeLV and FIV, perhaps through biting. The increased seropositive rate might also reflect the diminished capacity of the immune system. Cats previously infected by one retrovirus may be less able to recover after exposure to a second virus.

Increased prevalence of positive FeLV Ag and FIV Ab results in neutered cats, compared with sexually intact cats, reflects the greater age of the neutered cats. Mean age of the FeLV Ag-positive neutered cats was 2.3 years greater than that of the FeLV Ag-positive sexually intact cats. Similarly, mean age of the FIV Ab-positive neutered cats was 3.2 years greater than that of the FIV Ab-positive sexually intact cats. Increased prevalence in the neutered cats would be predicted on the basis of age difference alone, using data given in Table 3.

Prevalence of FIV Ab for the minimal risk populations was low. In addition to providing insight on rate of infection, seropositive rates for these low-risk populations is a reliable measurement of the maximal false-positive rate of the FIV Ab test. The percent positive rate for the minimal risk subgroups (Table 7) was 0.85% for the sexually intact subgroup and 0.73% for the subgroup <2 years old. The percent positive rate for known negative groups would be equal to or less than these values. These seropositive rates indicate that the FIV Ab test specificity is >99%. These data provide a practical estimate of the test specificity because they were calculated from results collected and reported by a wide variety of veterinary practitioners in the field using instructions supplied with the test kit.

Although the sampling for this survey was not truly random, results of this serosurvey document the widespread prevalence of FeLV and FIV infections in the high-risk national feline population. Overall, 5,791 cats (20.6%) of a total of 27,976 at-risk and symptomatic cats were infected with one or both retroviruses. The substantially higher prevalence of viral infection in the symptomatic cat population apparently reflects the disease-causing potential of the viruses. In this symptomatic population of cats (n = 12,602), 32.7% or almost 1 in 3 were found to be infected by FeLV, FIV, or both viruses.

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Hematologic abnormalities in cats seropositive for feline immunodeficiency virus

Grady H. Shelton, DVM; Michael L. Linenberger, MD; Janis L. Abkowitz, MD

Feline immunodeficiency virus (FIV), a retrovirus (subfamily, Lentivirinae), is associated with an immunodeficiency syndrome in domestic cats.[1] After a prolonged period when clinical signs of disease are not manifested (eg, months to years), FIV infection is characterized by a variety of chronic disorders, opportunistic infections, and neoplasia.[2,3] Morphologic and biologic properties of FIV closely resemble those of human immunodeficiency virus (HIV), a lentivirus that is the etiologic agent of acquired immunodeficiency syndrome (AIDS) in human beings.[1,2,6] Hematologic abnormalities are a common feature of HIV infection.[7-11] Although lymphopenia attributable to depletion of CD4-positive (helper/inducer) cells is the most prominent abnormality, other cytopenias are often seen. The prevalence of hematologic disorders increases with progression of HIV-associated disease.[8] In addition, drug-induced neutropenia is frequent in AIDS patients treated with antimicrobial agents, including trimethoprim-sulfamethoxazole, pyrimethamine-sulfadoxine, and pentamidine.[12-14] This adverse reaction contrasts to that of drugs that induce bone marrow suppression in HIV-seropositive and noninfected individuals. The pathogenesis of these HIV-associated hematologic abnormalities has yet to be elucidated.

The hematologic status of cats with naturally acquired FIV infection has been recently studied.[5,15,16] Cats with clinical signs of disease have blood and bone marrow abnormalities comparable to those reported in HIV-seropositive human beings.[15] Furthermore, FIV-infected cats appear to have increased incidence of drug (griseofulvin)-induced neutropenia.[16]

Blood Abnormalities

Hematologic variables, including CBC, total and differential WBC counts, and platelet numbers, were assessed in 53 cats referred to the clinic because of spontaneous FIV infection.[15] Diagnosis of FIV infection was based on detection of FIV-specific antibodies in serum, using ELISA[a] and immunoblot analysis (Western blot).[5] Eighteen cats (34%) were coinfected with FeLV as determined by either ELISA[b] or immunofluorescent antibody testing.[c]

Hematologic abnormalities were detected in 40 of 53 (75%) cats. Cytopenias were the most prevalent findings (Table 1). Overall, anemia, lymphopenia, neutropenia, and thrombocytopenia were observed in 36, 53, 34, and 8% of cats,

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From the Feline Retrovirus Clinic, Pacific Northwest Research Foundation (Shelton) and the Division of Hematology, Department of Medicine, University of Washington (Linenberger, Abkowitz), Seattle, WA 98195

Supported in part by research grants DK41934, CA21620, and HL02396 from the National Institutes of Health.

[a] FTLV PetChek ELISA, IDEXX Corp, Portland, Me.

[b] FeLV PetChek Screening Confirmatory ELISA, IDEXX Corp, Portland, Me.

[c] FeLeuk test, National Veterinary Laboratory, Franklin Lakes, NJ.

Ten-year study comparing enzyme-linked immunosorbent assay with the immunofluorescent antibody test for detection of feline leukemia virus infection in cats

William D. Hardy, Jr., VMD, and Evelyn E. Zuckerman, BS

Summary: *Immunodetection tests for feline retroviruses are powerful tools used in modern veterinary practice. Veterinarians must fully understand the characteristics—strengths and weaknesses—of the FeLV tests so that the information gained from them can be used properly. Any FeLV* ELISA *or immunofluorescent antibody (*IFA*) test is a method for detection of FeLV infection (the virus) and is not a diagnostic test for leukemia or other feline disease.*

From previous studies, it was determined that the most accurate test for detection of persistent FeLV infection is the IFA *test, which detects FeLV antigens in cytoplasm of leukocytes in the blood of infected cats. In the study reported here, 1,142,600 FeLV* IFA *tests were performed between June 1972 and December 1990. During this period 19.8% of the* IFA *test results were positive and 78% were negative. Evaluation was not possible for the remaining 2.2% of the tests because of lack of enough leukocytes in the smears to evaluate, or nonspecific staining reactions.*

In 1979, 7 years after introduction of the IFA *test, in-hospital FeLV* ELISA *were introduced, which enabled veterinarians to test for FeLV in their hospitals. Ever since that time, continual discrepancies have been reported between results of FeLV* ELISA *and* IFA *tests, particularly between positive* ELISA *results and their* IFA *test confirmation. A 10-year comparison was made between practitioner-performed in-hospital FeLV* ELISA *(n = 20, 240 tests) results and FeLV* IFA *test performed by a commercial laboratory. All samples tested by* ELISA *were submitted (for confirmation of results) by veterinarians from the United States, Canada, Europe, Japan, and Australia. There was 86.9% agreement between negative* ELISA *results and the* IFA *test result, but only 46.3% agreement between positive* ELISA *results and the* IFA *test result. Overall agreement was 49.0% for all confirmatory* IFA *tests. However, there was bias toward confirmation of positive* ELISA *results because 93% of confirmatory tests requested were of* ELISA*-positive samples.*

It is apparent from this study that between 26 and 69% of in-hospital positive ELISA *results and 13% of in-hospital negative* ELISA *results are incorrect. On the basis of these observations, we recommend that veterinarians immediately confirm all FeLV positive* ELISA *results by* IFA *testing. In addition, negative* ELISA *results in cats that the veterinarian suspects have FeLV infection or FeLV-induced disease should also be confirmed by* IFA *testing. We also recommend that all cats be vaccinated for FeLV and that they be tested for FeLV and the feline immunodeficiency virus at time of first vaccine dose.*

Retroviruses are 1 of the most important family of viruses that infect animals. Retroviral infections are often life-long chronic infections; healthy animals can carry these viruses for long periods and spread the viruses to other animals before they develop disease. Immunodetection tests for animal retroviruses are powerful tools in modern veterinary medicine, and such tests are available for the following retroviruses: FeLV, feline immunodeficiency virus (FIV), avian leukosis virus, bovine leukemia virus, and equine infectious anemia virus.

In 1972, we introduced the first routinely available test for any retrovirus, the immunofluorescent antibody (IFA) test for detection of FeLV infection in pet cats.[1] This test has been used to elucidate all FeLV-induced diseases, the biology of FeLV, and the pathogenesis of FeLV infection.[1-19] Since then, several FeLV ELISA, in various formats, have been introduced to veterinary medicine.[20-29] Currently, some of the ELISA can be performed in <20 minutes and contain disposable receptacles. Several of the ELISA kits were compared with the IFA test by the manufacturers and others, with claims of good agreement between the tests.[20-23,26-28]

Almost as soon as the first FeLV ELISA kit was introduced in 1979, discordant FeLV ELISA and IFA test results were obtained, especially between positive-ELISA results and confirmatory IFA test results.[18,20-23,26-27] Considerable controversy and confusion have arisen relating to discordant ELISA-

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From The Laboratory of Veterinary Oncology and The Infectious Disease Service, Department of Medicine, Memorial Sloan Kettering Cancer Center, New York, NY 10021 (Hardy, Zuckerman) and The National Veterinary Laboratory Inc, Franklin Lakes, NJ 07417. (Dr. Hardy is owner of the National Veterinary Library, Inc)

The authors thank V. Sellen, N. Westphal, A. Shipp, H. Perry, J. Perry, M. Bertero and G. Longo for technical assistance.

Table 1—Summary of FeLV immunofluorescent antibody (IFA) test results over 19 years*

Year	Results (%) Positive	Negative	No evaluation
1972	32.9	66.5	0.6
1973	32.9	66.5	0.6
1974	32.8	64.8	2.4
1975	32.9	64.3	2.8
1976	29.6	67.6	2.8
1977	28.5	69.2	2.3
1978	26.4	71.3	2.3
1979	23.8	72.6	3.6
1980	23.5	73.4	2.8
1981	21.8	70.6	3.1
1982	21.5	76.0	2.5
1983	20.5	77.4	2.1
1984	19.3	79.2	1.5
1985	9.7	89.0	1.3
1986	11.4	87.0	1.6
1987	11.9	86.4	1.7
1988	13.1	84.6	2.3
1989	14.8	83.4	1.8
1990	14.9	83.2	1.9
Total tests 1,142,600	19.8	78.0	2.2

*Performed by laboratory A

Table 2—Summary of a ten-year comparison of FeLV ELISA and IFA tests. Sept 1979 through Aug 1989

In-hospital ELISA* results	IFA No. tested	Test results† Negative	Positive	Percentage agreement (%)
Negative	1,332	1,158	174	86.9
Positive	18,908	10,147	8,761	46.3
Total	20,240	Overall agreement		49.0

*ELISA were performed by veterinary practitioners (n = 18,828 tests) or by veterinary diagnostic laboratories (n = 1,412 tests). Submissions are biased toward ELISA-positive result confirmations. †Performed by laboratory A on blood smears submitted by veterinary practitioners or local veterinary laboratories.

Table 3—Overall ten-year comparison of FeLV ELISA and IFA test by individual ELISA kit: September 1979 through August 1989*

ELISA test kit	ELISA result	No. tested	IFA result Negative	Positive	Percentage agreement (%)
Kit A	Negative	627	545	82	86.9
	Positive	8,492	5,210	3,282	38.7
Kit B	Negative	248	222	26	89.5
	Positive	2,326	612	1,714	73.7
Kit C	Negative	54	50	4	92.6
	Positive	1,280	792	488	38.1
Kit D (saliva)	Negative	25	21	4	84.0
	Positive	328	226	102	31.1
Kit E	Negative	89	77	12	86.5
	Positive	1,747	816	931	53.3
Unknown ELISA	Negative	51	46	5	90.2
Local laboratories	Positive	1,361	634	727	53.4
In-hospital	Negative	169	134	35	79.3
	Positive	1,968	1,030	938	47.7
	Negative	1,332	1,158	174	86.9
Total	Positive	18,908	10,147	8,761	46.3
		20,240	11,305	8,935	49.0

Overall agreement: Results for 9,919 of 20,240 (49.0%) total tests agreed

IFA tests performed by laboratory A.
This study was biased toward positive ELISA results confirmation.

*Table 4—Comparison of discordant ELISA and IFA results with isolation of FeLV in tissue culture**

Discordant FeLV results ELISA	IFA	Tissue culture isolation No. Tested	Results Positive	Negative
Positive	Negative	3	3	0
Negative	Positive	1	0	1

*100% agreement between IFA and tissue culture isolation results.

positive, IFA-negative test results.[24-43] Because of the continual problem of discrepant test results, we conducted a 10-year comparative study of 20,240 samples, tested by ELISA, results of which were confirmed or compared with results of our FeLV IFA test.[a] The purpose of the study reported here was to ascertain the degree of concordance between in-hospital performed FeLV ELISA and the IFA test to formulate algorithms and recommendations for use of FeLV tests and management of ELISA-positive cats.[44,45] The IFA test is considered the reference standard (ie, the test against which the accuracy of other tests for infection with a specific agent is judged) for FeLV infection.

Materials and Methods

Immunofluorescent antibody test procedure—Most of the IFA FeLV testing services were performed at laboratory A[a] between June 1, 1972 and December 31, 1990 (Table 1) on slides submitted by veterinarians from the United States, Canada, Mexico, Europe, Japan, and Australia. Comparative IFA confirmatory tests were conducted for 10 years between September 1, 1979 and August 31, 1989. Other comparative research IFA tests were performed at laboratory B.[b]

The IFA procedure was performed as described on blood smears mailed to the laboratory.[1,2,18,44-45] Good quality, thin feathered-edge, blood smears were fixed for 7 minutes in absolute methanol at 20 to 22 C (room temperature). Reaction wells (1.5-cm diameter) were drawn, using a china marker pencil, on the leading edge of the blood smears. Rabbit anti-FeLV serum, at dilution of 1:60, was placed in the reactive wells and slides were tested as described.[1,45] Each FeLV test was performed with 2 positive-control blood smears included.

ELISA procedure—All comparative FeLV ELISA were performed by veterinarians in their hospitals or by local veterinary diagnostic laboratories, using all of the commercially available ELISA kits (Tables 2 and 3). Blood smears from the 20,240 cats that were tested by ELISA were submitted by veterinarians to laboratory A for IFA test confirmation between September 1, 1979 and August 31, 1989 (Table 3).

Comparison of ELISA and IFA discordant results with tissue culture isolation of FeLV—Three discordant ELISA-positive, IFA-negative cat sera and 1 dis-

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[a] National Veterinary Laboratory Inc, Franklin Lakes, NJ.

[b] Laboratory of Veterinary Oncology, Memorial Sloan Kettering Cancer Center, New York, NY.

Table 5—Retesting of 48 FeLV ELISA/IFA discordant cats

Initial FeLV test results		Retests of discordant cats: No change of results—Retest Results		Change of results Retest results	
ELISA + IFA −	ELISA − IFA +	ELISA + IFA −	ELISA − IFA +	ELISA + to − IFA − to −	ELISA − to + IFA + to +
47	1	13	1	34	0
48		(27.1%)	(2.1%)	(70.8%)	(0%)

Table 6—Comparative sensitivities of FeLV tests

Dilution of blood* in saline solution	Comparative tests: Immunodiffusion	IFA†	ELISA‡
Undiluted	+	+	+
1:10	[illegible]	+	+w
1:100	[illegible]	+	[illegible]
1:1,000	[illegible]	+w	[illegible]

*Blood from 2 FeLV-positive cats. †Performed by laboratory A. ‡Kit B.
+ = positive; − = negative; w = weak reaction.

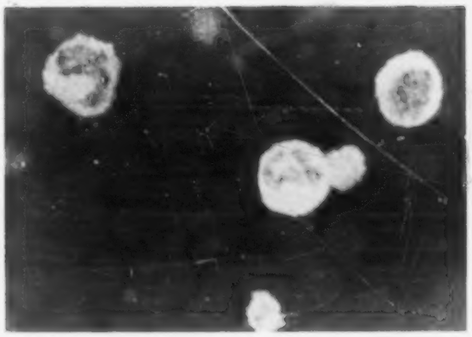

Figure 1—Positive immunofluorescent antibody (IFA) test result on a blood smear from a cat. The FeLV antigens are in neutrophils, lymphocytes, and platelets.

cordant ELISA-negative, IFA-positive cat serum were tested for FeLV by tissue culture isolation (TCI) (Table 4). Sera were obtained fresh and were inoculated within 3 hours onto feline embryo fibroblast (FEF-3) cell cultures.

Retests of ELISA/IFA discordant cats—A group of 48 ELISA/IFA discordant cats were retested by ELISA and IFA within 1 week after obtaining original ELISA/IFA discordant test results (Table 5). The same ELISA kit[c] (kit A) that was used for the original ELISA was used to retest each cat, and blood smears were prepared at the same time for confirmatory IFA retesting.

Comparative sensitivities of FeLV tests—Relative sensitivities of various FeLV immunodetection tests were evaluated by obtaining sera and blood smears from 2 FeLV-infected cats. Each serum was tested by immunodiffusion (ID)[45,46] and ELISA[d] (kit B) undiluted and at various dilutions in phosphate-buffered saline solution (PBSS): 1:10, 1:100, and 1:1,000 (Table 6). Blood smears were prepared and tested by IFA after blood samples were diluted in PBSS.

Figure 2—Negative IFA test result on a blood smear from a cat. No FeLV antigens are in the neutrophils and lymphocytes.

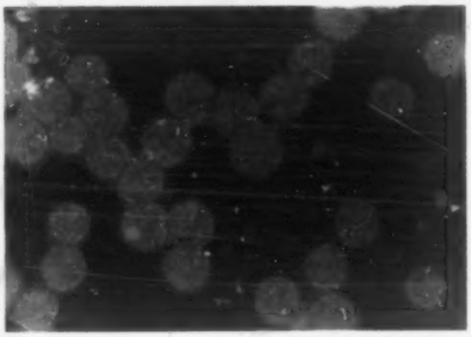

Figure 3—An FeLV IFA test on blood smears from a cat with severe leukopenia. Leukocytes are not in the smear, and thus, evaluation is not possible.

Results

IFA testing—The IFA test for FeLV detects FeLV antigens as apple-green punctate fluorescent granules in the cytoplasm of neutrophils, eosinophils, lymphocytes, and platelets in blood smears (Fig 1). All leukocytes are FeLV antigen-positive in most IFA-positive cats. Occasionally however, only 10 to 90% of the leukocytes will be positive for FeLV antigens. In this instance, the IFA test is positive for FeLV infection and the veterinarian is advised to recommend isolation of the cat and to retest the cat in 1 month. The 1-month retest is suggested to determine whether the cat's leukocytes will become 100% antigen-positive or 100% antigen-negative. Cats with <100% IFA antigen-positive leukocytes are either in the early stages of infection or are in the act of rejecting FeLV infection and becoming immune. The ELISA are not able to identify this type of early infection or rejection of the virus.

No fluorescence is seen in noninfected cat leukocytes, which appear red because of the Evans blue counter stain (Fig 2). The IFA test is difficult to

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[c] Leukassay-F, Pitman-Moore, Inc., Mundelein, Ill.
[d] CITE, Idexx Corp, Portland, Me.

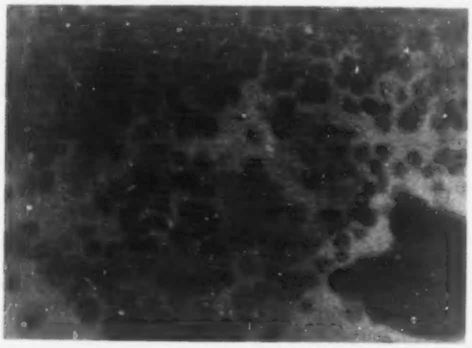

Figure 4—An IFA test on a blood smear that is too thick. This causes a no-evaluation result because of nonspecific reaction.

*Table 7—Calculation of the sensitivity and specificity of in-hospital ELISA**

ELISA results	Reference Standard results	
	Positive	**Negative**
Positive	a = 8,761	b = 10,147
Negative	c = 174	d = 1,158

Let a = IFA/ELISA-pocitive; b = IFA-negative, ELISA-positive; c = IFA-positive/ELISA-negative; d = IFA/ELISA-negative results. Total tested = a + c + b + d = 20,240 Overall agreement = 49.0%

*Data biased toward confirmation of positive ELISA results; thus, these specificity data do not represent true unselected values

Calculations:

$$\text{ELISA Sensitivity} = \frac{a}{a + c} \times 100 = \frac{8{,}761}{8{,}761 + 174} \times 100 = 98.1\%$$

$$\text{ELISA Specificity} = \frac{d}{b + d} \times 100 + \frac{1{,}158}{10{,}147 + 1{,}158} \times 100 = 10.2\%$$

$$\text{ELISA false negative rate} = \frac{c}{a + c} \times 100 = \frac{174}{8{,}761 + 174} \times 100 = 2.0\%$$

$$\text{ELISA false positive rate} = \frac{b}{b + d} \times 100 = \frac{10{,}147}{10{,}147 + 1{,}158} \times 100 = 89.8\%$$

interpret in cats that are leukopenic because of low numbers or lack of leukocytes (Fig 3). Blood smears that are too thick are also difficult to interpret because of lack of visible leukocytes within the heavy cell layer and because of the nonspecific reaction attributable to the trapping of the IFA reagents (Fig 4).

Between June 1, 1972 and December 31, 1990, laboratory A performed 1,142,600 IFA tests (Table 1), of which 19.8% had positive results and, 78.0% had negative results; in 2.2%, evaluation was not possible because of lack of leukocytes in the smears or nonspecific staining reaction. A higher percentage of positive results was obtained from 1972 through 1978 than in more recent years, from 1979 through 1990.

IFA and ELISA comparative testing—For 10 years, between September 1, 1979 and August 31, 1989, laboratory A performed IFA confirmatory testing of samples from 20,240 cats that had been tested for FeLV by in-hospital ELISA (Tables 2 and 3). All 6 commercially available ELISA kits were compared with the IFA test.

As can be seen from the data in Table 2, the overall concordance of ELISA and IFA tests was only 49%. However, it should be noted that most (93%) of the confirmatory tests that were requested by veterinarians were for positive ELISA results, which introduced bias toward confirmation of positive ELISA results. There was 46.3% agreement between positive ELISA results and positive IFA results. The concordance for negative ELISA results was higher, with 86.9% agreement. However, this indicates that 13.1% of negative ELISA results were positive by IFA testing.

Concordance between ELISA results of each manufacturer's ELISA kit and the IFA test was calculated (Table 3). The ELISA kit with the highest concordance for FeLV-positive results was kit B[d] with 73.7% agreement, whereas the ELISA kit with the highest concordance for FeLV-negative results was kit C[e] with 92.6% agreement. The ELISA with the lowest concordance for FeLV-positive results were those used for testing saliva (kits C[e] and D[f]) with agreement of only 31.1 and 38.1%, respectively.

The ELISA with the lowest concordance for FeLV-negative results were also used for testing saliva (kits D[f] and E[g]) with agreement of 84.0 and 86.5%, respectively.

Analysis of these data indicated that overall sensitivity (Table 7) of the ELISA was 98.1%, specificity was 10.2%, false-negative rate was 2.0%, and false-positive rate was 89.8%. These findings are distorted because more positive ELISA results were confirmed than were negative ELISA results. However these data clearly document that numerous false-positive in-hospital FeLV ELISA results are common.

Comparison of ELISA and IFA discordant results with TCI—Results of FeLV TCI agreed with IFA results in all 4 of the ELISA and IFA discordant cats tested (Table 4).

Retesting of ELISA/IFA discordant cats—Forty-eight ELISA/IFA discordant cats were retested by veterinarians within 1 week after results were initially obtained (Table 5). Of the 48 cats, 47 were initially ELISA-positive, IFA-negative, whereas 1 was initially ELISA-negative, IFA-positive. The ELISA and IFA retest results of 13 of the 47 initially ELISA-positive, IFA-negative cats and the 1 initially ELISA-negative, IFA-positive cat did not change. However, the ELISA results of retesting of 34 of the 47 (70.8%) initially ELISA-positive, IFA-negative discordant cats changed to ELISA-negative, whereas the IFA results remained unchanged and were still negative. These comparative retest results indicate that 70.8% of the initial ELISA results for cats in the ELISA/IFA discordant group were incorrect.

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[e] Virachek, Synbiotics Inc, San Diego, Calif.

[f] ClinEase, Norden Laboratories, Lincoln, Neb.

[g] Diasystems, TechAmerica Veterinary Products, Kansas City, Mo.

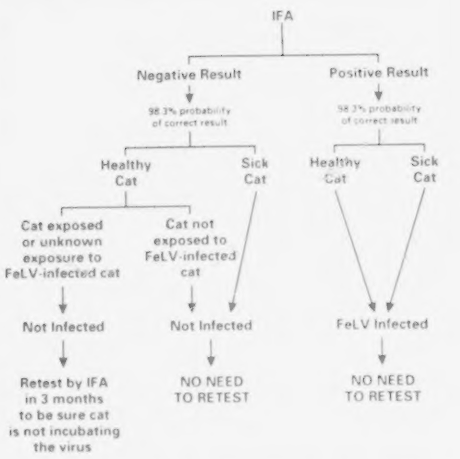
IFA
Negative Result
98.3% probability of correct result
Positive Result
98.3% probability of correct result
Healthy Cat
Sick Cat
Healthy Cat
Sick Cat
Cat exposed or unknown exposure to FeLV-infected cat
Cat not exposed to FeLV-infected cat
Not Infected
Not Infected
FeLV Infected
Retest by IFA in 3 months to be sure cat is not incubating the virus
NO NEED TO RETEST
NO NEED TO RETEST

Figure 5—Algorithm for management of cats tested for FeLV infection by the immunofluorescent antibody (IFA) test.

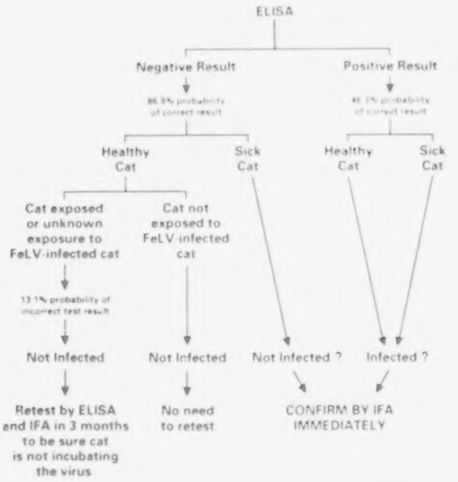
ELISA
Negative Result
86.9% probability of correct result
Positive Result
46.3% probability of correct result
Healthy Cat
Sick Cat
Healthy Cat
Sick Cat
Cat exposed or unknown exposure to FeLV-infected cat
Cat not exposed to FeLV-infected cat
13.1% probability of incorrect test result
Not Infected
Not Infected
Not Infected ?
Infected ?
Retest by ELISA and IFA in 3 months to be sure cat is not incubating the virus
No need to retest
CONFIRM BY IFA IMMEDIATELY

Figure 6—Algorithm for management of cats tested for FeLV infection by ELISA.

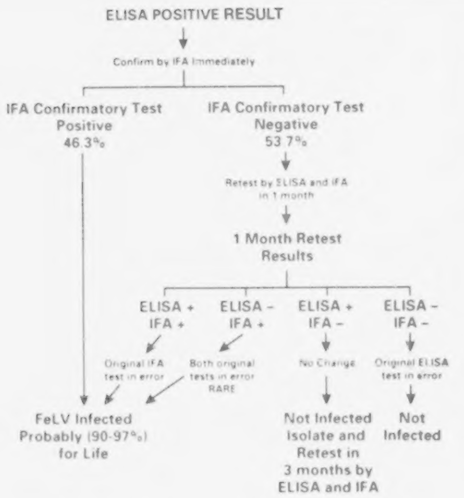
ELISA POSITIVE RESULT
Confirm by IFA Immediately
IFA Confirmatory Test Positive 46.3%
IFA Confirmatory Test Negative 53.7%
Retest by ELISA and IFA in 1 month
1 Month Retest Results
ELISA + IFA +
ELISA – IFA +
ELISA + IFA –
ELISA – IFA –
Original IFA test in error
Both original tests in error RARE
No Change
Original ELISA test in error
FeLV Infected Probably (90-97%) for Life
Not Infected Isolate and Retest in 3 months by ELISA and IFA
Not Infected

Figure 7—Algorithm for management of cats tested for FeLV infection by ELISA and confirmed by IFA testing.

Comparative sensitivities of FeLV tests—Sera and blood from 2 FeLV-positive cats were diluted and tested by ID, IFA, and ELISA[d] (Table 6). The ID test result was positive only when undiluted sera were tested, the ELISA result was weakly positive for sera diluted 1:10, and the IFA test result was weakly positive for blood diluted 1:1,000. In other experiments (not described here), it was possible to consistently detect, by use of the IFA test, 1 FeLV-infected leukocyte mixed with 100,000 noninfected leukocytes.

Discussion

This study was initiated by veterinarians who submitted samples for IFA testing for confirmation of results of ELISA performed in their hospitals or at veterinary diagnostic laboratories. During the 10 years of this study, 20,240 confirmatory IFA tests were performed. Agreement between in-hospital performed FeLV ELISA and the IFA test was 86.9% for negative ELISA results and was 46.3% for positive ELISA results. It should be noted that 93% of all of samples submitted by veterinarians for confirmation had positive ELISA results, which introduced bias in the test selection. Practitioners apparently believed that their negative ELISA results were more reliable than their positive ELISA results. This assumption was correct, although 13.1% of all negative ELISA results were incorrect. These findings indicate that veterinarians should be more aware that even their negative ELISA results may be incorrect.

When the 4 discordant ELISA/IFA results were compared with TCI of the virus, all 4 TCI results agreed with the IFA test result. When samples with ELISA/IFA discordant results were immediately retested by ELISA and the IFA test, 70.8% of the original ELISA results changed and, thus, had been incorrect. In this retesting program, none of the IFA test results changed. The sensitivity of the IFA test was found to be higher than that of the ELISA when studied in dilution experiments. Results indicate that the IFA test is still the most accurate FeLV test for detection of persistent FeLV infection.

The biology of the virus and pathogenesis of FeLV infection have been elucidated by use of the IFA test.[1-19] In contrast, the biology of FeLV in ELISA-positive pet cats has not been extensively studied and the outcome of ELISA-positive, IFA-negative discordant cats is not known.[26-31] However, the biology of FeLV in ELISA (true)–positive cats should be identical to that of FeLV in IFA-positive cats.

The management of FeLV ELISA-positive cats is a substantial problem for veterinarians.[3,4,13,14,44,45,47] Conflicting recommendations have been made regarding the disposition and management of these cats. Some veterinarians recommend isolation of ELISA-positive cats in multicat households, others recommend that these cats be retested, by ELISA, in 1 month, and still others recommend euthanasia. Many veterinarians, however, recommend immediate IFA test confirmation of the positive ELISA result before making any decision concerning management of such cats.

We have developed 3 FeLV test algorithms to guide veterinarians for use with the FeLV IFA test and ELISA (Figs 5-7). The algorithm for the FeLV IFA test is based on studies that established the IFA test as the most accurate of FeLV tests (Fig 5).[1,45] There is 98.3% probability that an IFA test result is correct.[45] Thus, there is no need to retest cats that were tested by IFA, except IFA-negative cats that have been recently exposed to an FeLV infected cat or cats that have unknown exposure, such as stray cats. These cats should be retested 3 months after the first test to be sure they were not incubating the virus at that time.

The algorithm for FeLV ELISA also was developed (Fig 6). There is 86.9% probability that a negative ELISA result is correct. If the negative ELISA result is in a healthy cat exposed to an FeLV-infected cat, the former cat should be retested in 3 months by ELISA and the IFA test to be sure the cat was not incubating the virus. If the negative ELISA result is in a healthy cat that was not exposed to an FeLV-infected cat, there is no need for FeLV retesting. All sick cats with negative ELISA results, should have those results confirmed by the IFA test immediately if the veterinarian suspects FeLV-induced disease. There is only 46.3% probability that a positive ELISA result is correct. Thus, we recommend that positive ELISA results in all healthy and sick cats be immediately confirmed by IFA testing.

An algorithm for ELISA-positive IFA confirmatory testing was developed (Fig 7). In-hospital positive ELISA results are confirmed to be positive by IFA 46.3% of the time. Cats with such results are infected and 90 to 97% of them will remain infected for life. However, 53.7% of the positive ELISA results are not confirmed by IFA testing and thus, are negative. Cats with such results should be retested 1 month later by ELISA and IFA testing. If the IFA confirmatory test result is positive, the cat should be considered viremic and most likely will remain infected for life. However if the IFA confirmatory test result is negative, the veterinarian should inform the cat's owner of the discordant results and recommend retesting of the cat, using both tests, in 1 month. If the 1-month retest ELISA result changes from positive to negative but the IFA test result remains negative, the cat should be considered free of FeLV infection and the initial ELISA result should be considered erroneous. If the 1-month ELISA result is again positive and the IFA test result remains negative, the cat should be considered to be aviremic and not shedding the virus in the saliva. However if possible, these cats should be kept away from other cats and they should be retested once more, by ELISA and the IFA test, 3 months after the initial FeLV test.

Table 8—Summary of frequency of FeLV infections in stray or randomly selected cats classified by IFA test OR ELISA method

Region	Year	FeLV frequency (%)	No. of cats tested	FeLV test method	Reference
New York City and Boston	1973	0.3	638	IFA	2
Boston	1975	1.8	114	IFA	5
New York City	1981	1.0	1,290	IFA	18
San Diego	1981	0.6	158	IFA	18
Boston	1981	0	120	IFA	18
King County, WA	1981	4.9	1,451	IFA	54
Northwest US	1981	5.2	232	IFA	54
New York City	1990	2.1	4,191	IFA	*
Total IFA		2.3	8,194		
San Antonio	1984	13.6	44	ELISA	43
Hillsborough County, Florida	1984	9.4	555	ELISA	33
US and Canada	1989	13.3	1,609	ELISA	55
Japan	1989	12.4	700	ELISA	56
Southeast Texas	1990	18.0	156	ELISA	57
Total ELISA		12.7	3,064		

Adapted from reference 33.

*Data from National Veterinary Laboratory, Inc.

The FeLV ELISA-positive, IFA-negative discordant cats that retest ELISA positive and IFA positive at the 1-month retest should be considered viremic and the initial IFA test should be considered erroneous. In this case, the explanation that the IFA test result changed from negative to positive because the cat was incubating FeLV and the IFA test was less sensitive than the ELISA at detecting this early infection seems unlikely because of our ID, IFA, and ELISA comparative sensitivity studies. It is not desirable for any FeLV test to be so sensitive that it will detect early local tissue infection not accompanied by persistent viremia because it is known that some cats (42%) will reject initial local infection and become FeLV-free and immune.[10-12,15,18] Cats with latent FeLV infection do not have replicating FeLV in their tissues, and thus, these cats will not test positive by the IFA test or ELISA.[48,49,50] A practical and useful FeLV test is one that will only detect persistent viremia in cats that do not reject initial infection.

Feline leukemia virus tests should be used in conjunction with FeLV vaccination to prevent spread of this deadly virus among cats.[51,52,53] The FeLV test-and-removal program has been successful worldwide in eliminating the spread of FeLV in multicat households even before introduction of the FeLV vaccines.[3,4,13,14] However, we now recommend that all cats be inoculated with an FeLV vaccine in conjunction with an FeLV and FIV prevaccination screening program. Cats should be tested for FeLV and FIV at the initial office visit. Blood should be drawn for the FeLV and FIV tests, and the first dose of the FeLV vaccine should be given. If the FeLV test result is obtained after the office visit is completed, it should be forwarded to the owner. It seems more economical to begin vaccination of cats with the first dose even before their FeLV status is known, because only 2.3% of random healthy cats, on the basis of IFA test surveys (Table 8), are expected to be infected with the virus.[15,16,18] The ELISA incidence data of random healthy cats are much higher than those compiled for the IFA test (Table 8), and we believe they represent an overestimate based on false-positive ELISA results that were not confirmed by IFA testing.[2,5,18,33,43,54-56]

Any cat that tests positive for FeLV after being given the first dose of the FeLV vaccine should be isolated from other cats and, although the vaccine is not harmful to infected cats, there appears to be no benefit to continuing the vaccination program in such cats. Healthy cats that test negative for FeLV and positive for FIV should be vaccinated for FeLV but should be kept indoors to prevent the spread of FIV through fighting and biting.[57] Because FeLV infection is life-long in 90 to 97% of IFA-positive cats and effective anti-viral treatment is not available, it is important to identify healthy FeLV carrier cats so they can be removed from contact with other cats.[58] The FeLV test-and-removal program is an excellent example of an efficient and effective anti-retroviral preventive veterinary medicine program.[3,4,13,14]

The percentage of positive IFA test results apparently decreased from 1972 to the present. A higher percentage of positive FeLV test results was observed in the years 1972 through 1978, than in more recent years. One explanation is that in the early 1970s, veterinarians were mainly testing sick cats or cats known to have been exposed to FeLV-infected cats. Another possibility is that, with the introduction of the first vaccine for FeLV in 1985, many veterinarians began prevaccination FeLV screening programs of more healthy FeLV-nonexposed cats. A review of 1,417 IFA test requisition forms from 1990 indicates that more healthy cats are currently being tested than were tested in the early 1970s. Currently, it is difficult to determine whether FeLV vaccines have reduced prevalence of FeLV-infected cats in the general population.

In this study, analysis of the comparison of practitioner-performed in-hospital ELISA with the IFA test performed by a specialized retrovirus testing laboratory indicated that more than half of positive ELISA results were incorrect. Results of this study are biased toward confirmation of a large number (n = 18,908), of positive ELISA results and only a relatively small number (n = 1,332) of negative ELISA results. However, our results indicate that many in-hospital positive ELISA results are incorrect and support the recommendation that all positive ELISA results be confirmed by IFA testing.

During the past several years, better correlation has been reported between ELISA and other IFA and virus-isolation tests done in university research laboratories.[18,20-44] Unlike our study, none of those studies compared large numbers of in-hospital performed ELISA. The probable explanation for the differing results between those comparative studies and our study is the fact that all comparative tests, ELISA and confirmatory tests, were performed by skilled laboratory-trained technicians in the other studies and not by veterinary hospital personnel as was associated with our study. Our study encompassed more than 1,000 veterinary hospitals where there probably were differing degrees of technical laboratory competence.

Many clinically oriented reviews exist of the biology of FeLV and the diseases induced by this virus.[3,17,18,47,59,60] Veterinarians in small animal practice, where cats now comprise more than half of all patients, must familiarize themselves with this virus and the methods used to detect infected cats. Veterinarians must also fully understand the characteristics (strengths and weaknesses) of the FeLV tests they use, so that the information gained from these tests can be used properly. An FeLV test is for detection of the virus and is not a diagnostic test for leukemia or any other feline disease.[44,45]

Careful confirmation of all positive retroviral test results should be done to practice the highest standards of veterinary medicine. In this regard, results of all retroviral screening ELISA for the human immunodeficiency virus types 1 and 2, and the human T-lymphotropic retrovirus types I and II are confirmed by more specific western blot assays before any person is informed of positive retroviral status. A similar standard should be adopted in veterinary medicine where routine retroviral testing was introduced and practiced 10 years before similar tests were available in human medicine.

As a result of this study, we recommend that all FeLV ELISA-positive cats have such results immediately confirmed by IFA testing.

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Comparison of four test kits for feline leukemia virus antigen

Darren M. Hawks, DVM; Alfred M. Legendre, DVM, MS; Barton W. Rohrbach, VMD, MPH

Summary: *The sensitivity and specificity of 4 commercial FeLV ELISA kits, using blood, were compared with results of virus isolation from blood and immunofluorescent antibody (IFA) testing on blood. Significant differences were not found among the 4 ELISA kits. Marked decrease in sensitivity of the ELISA kits was detected when virus isolation was used as the standard of positivity rather than the IFA test. Virus isolation was a more sensitive indicator of early infection, with marked discrepancy among results obtained by virus isolation, ELISA, and the IFA test. Results became progressively more concordant as infection became fully established. Cats FeLV-positive by virus isolation alone were more likely to eliminate viremia. All cats FeLV-positive by IFA testing remained persistently viremic. Virus isolation, ELISA, and IFA testing appear to differ in their prognostic value. The use of blood rather than serum for the ELISA resulted in several discordant results. Six cats were FeLV-positive by ELISA when blood was tested but were FeLV-negative when serum was tested. Positive ELISA results were obtained for 4 of these cats when serum was tested, using extended incubation to increase sensitivity. It is possible that blood may actually be more sensitive than serum for use of the ELISA method.*

Detection of FeLV infection by use of an ELISA on serum is a sensitive, accurate, and simple procedure. Results of ELISA on serum were correlated (95%) to immunofluorescent antibody (IFA) detection of FeLV[1] on blood. Discrepancy usually is attributed to increased sensitivity of ELISA technology and to the ability of ELISA to detect infection prior to bone marrow involvement. False-negative IFA test results can be obtained when antigen concentration is low, when FeLV infection is sequestered outside the bone marrow, or when too few leukocytes are available to evaluate. False-positive ELISA results are attributable to improper washing technique or to anti-mouse immunoglobulin activity in the sample.[2]

In a recent study, 7 commercially available ELISA kits were compared using serum from known IFA-positive cats and FeLV-negative specific-pathogen-free (SPF) cats.[3] Since that report was published, several new or modified ELISA kits have been introduced on the market. To our knowledge, the sensitivity of FeLV ELISA kits, using a standard of virus isolation, has not yet been evaluated.

Many veterinarians use blood rather than serum when performing ELISA. Testing of blood may result in more false-positive reactions than does testing of serum.[4] False-positive results are attributed to the difficulty of adequate washing.[4] Serum samples were used in the previous study comparing ELISA kits.[3] To the authors' knowledge, direct comparison of specificity between use of blood and serum for ELISA kits has not been previously reported.

The objective of the study reported here was to compare the sensitivity and specificity of 4 commercially available FeLV ELISA kits, using blood, with IFA and virus isolation methods.

Materials and Methods

Commercially available ELISA kits—Four FeLV

From the Department of Urban Practice (Hawks, Legendre) and the Department of Rural Practice (Rohrbach), College of Veterinary Medicine, University of Tennessee, Knoxville, TN 37901.

Supported by IDEXX Corporation, Portland, ME. Test kits were generously provided by their respective manufacturers.

The authors thank Shawna Doan for technical assistance.

December 1, 1991 Volume 199 Number 11

JOURNAL
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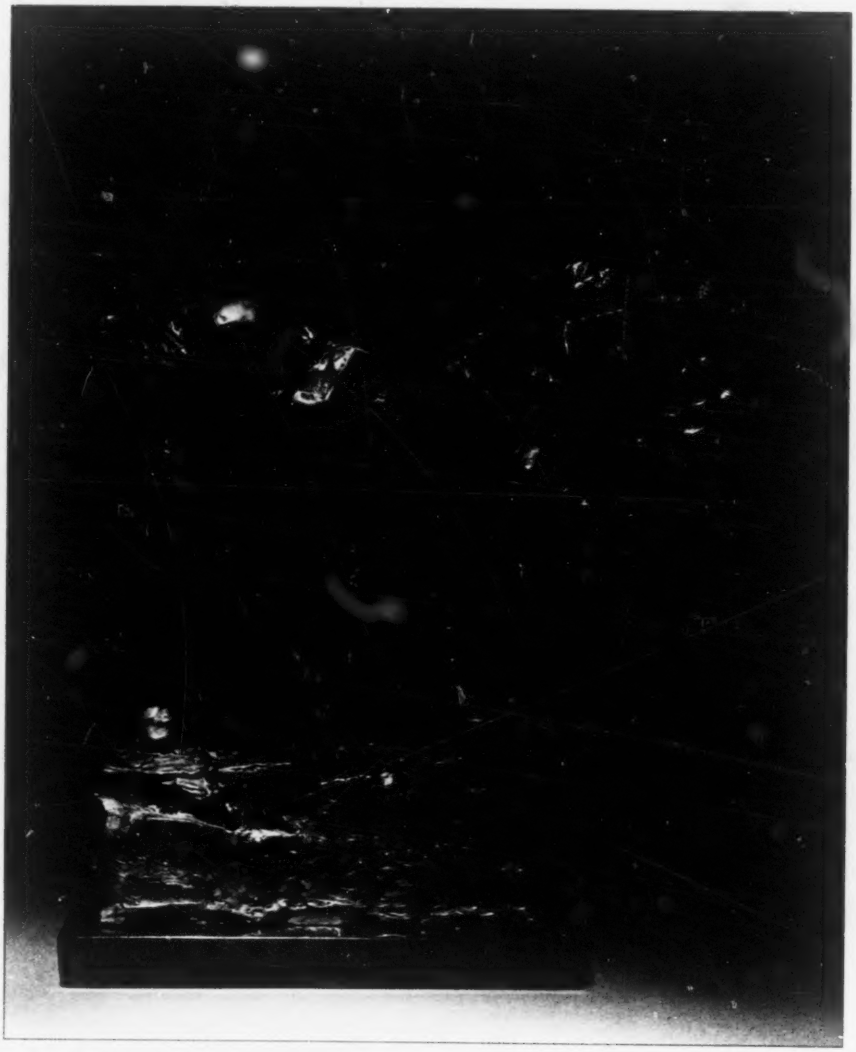

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Vol 199 December 1, 1991 No. 11
JAVMA 199 (11) 1521-1672 (1991)
ISSN 0003-1488

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SUBSCRIPTIONS: For one year: members $35; others $70 in the United States and possessions; $90 in foreign countries. Single copies: $6.00 in the United States and possessions; $8.00 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1991 by the AVMA.

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BPA

Special Report

Comparison of bovine spongiform encephalopathy risk factors in the United States and Great Britain

Kevin D. Walker, PhD; William D. Hueston, DVM, PhD; H. Scott Hurd, DVM, PhD;
John W. Wilesmith, BVSc

Bovine spongiform encephalopathy (BSE) was first described in Great Britain in 1986.[1] This new disease, the first subacute transmissible spongiform encephalopathy identified in cattle, is postulated to be the bovine equivalent of the sheep scrapie agent.[2]

The BSE epizootic accumulated over 30,000 cases in Great Britain by the end of June 1991, with exported British cattle also succumbing in Northern Ireland,[a] Oman,[3] and the Republic of Ireland. Additional cases in native cattle have been diagnosed in the Channel Isles and Isle of Man,[4] France,[5] Northern Ireland,[a] the Republic of Ireland,[6] and Switzerland.[7]

Cases of BSE have not been confirmed in the United States, although an outbreak of transmissible mink encephalopathy has been putatively attributed to a scrapie-like infection in cattle by Marsh.[8] Nevertheless, scrapie disease exists in US sheep, raising concern over the potential for development of BSE in native US cattle.[9]

The purpose of this report was to quantify, compare, and assess risk factors in the United States with BSE risk factors in Great Britain. This includes identification and discussion of potential routes of introduction and transmission of BSE in the United States. Also addressed is the role of risk assessment in understanding diseases such as BSE.

BSE epidemiologic findings in Great Britain

The clinical expression of BSE is a central nervous system disorder with marked similarities to subacute transmissible spongiform encephalopathies in other species.[2] Increased apprehension, ataxia, gait abnormalities, loss of body weight, reduced milk production, and hypersensitivity are the most common signs.

Over 97% of the BSE cases have developed in dairy cattle or dairy crossbreeds. The average age at onset is 4 to 5 years.[2] Breed or gender predisposition has not been found. Examination of records of affected herds revealed cattle with similar clinical signs in 1985. The development of BSE was sporadic prior to midyear 1986 when the observed incidence increased substantially.

On the basis of the initial BSE investigations, the exposure began between 1981 and 1982.[2] The epizootic curve matched that of an extended common source exposure. Extensive epidemiologic inquiries implicated the feeding of rendered animal proteins as the source of exposure after no common case links were detected for vaccines, pharmaceuticals, pesticides, or insecticides, or other management factors. To date, no horizontal transmission has been documented. A single case of putative maternal transmission has been reported.

The onset of exposure to the BSE agent was temporally related to two rendering process changes: the adoption of a continuous manufacturing process, and the cessation of hydrocarbon solvent extraction of fat from meat and bone meal.[10] These changes in the rendering industry were postulated to increase the survival of the BSE agent in animal protein products that were used in animal feeds. The resulting larger exposure received by cattle ingesting the affected feeds shortened the incubation period and enabled clinical signs to be observed during the lifetime of the cattle. The overrepresentation of dairy cattle in the BSE epizootic apparently resulted from the greater consumption of concentrate feeds by dairy cattle as opposed to that by beef cattle.[11]

The disease BSE is suggested to be the clinical manifestation of the sheep scrapie agent in cattle rather than a new agent or hitherto unrecognized spongiform encephalopathy agent latent in the cattle population. Consequently, the source of the BSE agent seems to have been scrapie-infected sheep. Scrapie is a disease of mature sheep, with high titers of the agent not developing until adulthood, so sheep older than 1 year are the most likely source. Scrapie is widespread in Great Britain and may have been increasing over the past decade.[4]

Meat and bone meal (including rendered ma-

From Animal Health Information Programs, USDA-APHIS, Veterinary Services, 555 S Howes, Fort Collins, CO 80521 (Walker, Hueston, Hurd) and the Epidemiology Unit, Central Veterinary Laboratory, United Kingdom Ministry of Agriculture, Fisheries and Food, New Haw, Weybridge, Surrey KT15 3NB, England (Wilesmith).

[a] Denny OB. Veterinary Services, Department of Agriculture for Northern Ireland, Belfast, Northern Ireland: Personal communication, 1991.

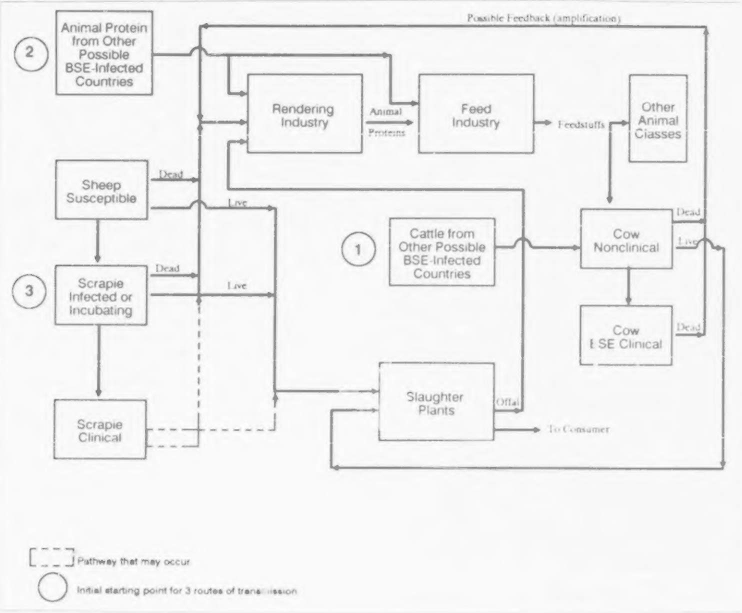
Possible Feedback (amplification)
2
Animal Protein from Other Possible BSE-Infected Countries
Rendering Industry
Animal Proteins
Feed Industry
Feedstuffs
Other Animal Classes
Sheep Susceptible
Dead
Live
3
Scrapie Infected or Incubating
Dead
Live
1
Cattle from Other Possible BSE-Infected Countries
Cow Nonclinical
Dead
Live
Cow BSE Clinical
Dead
Scrapie Clinical
Slaughter Plants
Offal
To Consumer
Pathway that may occur
Initial starting point for 3 routes of transmission

Figure 1—Systems model of hypothesized bovine spongiform encephalopathy epidemiology. Potential routes of transmission in the United States. Source: USDA-APHIS Veterinary Services.

ture sheep products) has been a common component of cattle feeds in Great Britain[2] as a protein supplement in concentrates for lactating dairy cows as well as starter rations for 1- to 4-month-old calves. Cases of BSE have been confirmed in dairy cattle for which the exposure to meat and bone meal was calf starter rations.[12] All cattle with confirmed cases of BSE to date have received meat and bone meal as part of calf starter rations or adult concentrates.

Potential routes of transmission in the United States

The hypothesized transmission of BSE can be diagrammed with a systems model (Figure 1). For the United States, 3 possible transmission routes are represented: imported cattle carrying BSE, imported meat and bone meal containing the BSE agent, and native cattle infected via consumption of domestically produced meat and bone meal containing infected sheep products.

In the past 10 years, approximately 459 cattle, of which 445 were beef breeds, have been imported into the United States from the United Kingdom and Ireland. Further importation has been cancelled, and clinical cases of BSE have not been identified in imported animals. The potential risk of BSE attributable to imported cattle appears to be small.

The risk of BSE from imported animal protein products to cattle in the United States appears to be small. According to GB export data,[b] from 1982 to 1990, two shipments of animal protein products were sent to the United States; 10.3 tonnes (metric ton) in 1984 and 2 tonnes in 1985. By comparison, domestic animal protein production exceeded 3.3 million tonnes in 1989 alone.

The third route of transmission carries the greatest risk of BSE to cattle in the United States because of similarities in the source, manufacturing process, and use of animal protein products as identified in Great Britain. Cattle feed can be made from rendered sheep products derived from commercial slaughter or from dead, dying, or scrapie-infected sheep. Although the infectious dose is unknown and oral ingestion is not an efficient route of exposure, this appears to be the path of transmission in Great Britain. If cattle are being infected, the agent may be recirculating through the rendering of cattle offal.

In Great Britain, clinical signs of BSE appear to have resulted from an increase in the exposure dose received by cattle subsequent to a large increase in the population and slaughter of sheep relative to cattle, the widespread prevalence and apparent increase of scrapie in sheep, and a change in the rendering process that increased the survival of the scrapie agent in meat and bone meal.

In the United States, the risk of BSE can be qualitatively assessed by evaluating inventory and total production of sheep and beef and dairy animals; geographic location, density, and proximity of various animal species; prevalence and distribution of scrapie in sheep; concentration and product mix of animal offal produced at slaughter; total production and usage of animal protein and feed products, and the structure, technology, government policies, and economic conditions that may facilitate transmission of the agent.

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[b] Lawrence A. United Kingdom Ministry of Agriculture, Fisheries and Food: Unpublished data, 1991.

Comparison of the United States with Great Britain

Sheep industry and demographics—The trends in sheep population for Great Britain (England, Scotland, Wales) and the United States have moved in opposite directions (Figure 2). Since 1980, GB sheep inventories increased 33%, to 40.2 million by 1989.[13] In the United States, sheep inventories decreased from a 1942 peak of 47 million head to 10.9 million head by 1989.[14]

Sheep in Great Britain are distributed across a land area slightly smaller than the state of Oregon. Sheep in the United States are dispersed over a much larger landmass, with 2 regions of concentration; 80% are in the 17 western states, and most of the remaining 20% are clustered in the upper midwestern states.[14]

At 82,000 sheep farms, Great Britain has 10,000 fewer sheep farms than the United States, but almost 4 times as many sheep. Flock size distributions differ markedly. Fifty percent of the US farms are in the smallest category of 1 to 24 head, compared with only 11.5% of GB farms[13-15] (Table 1). Farms with over 1,000 head account for more than half of the sheep in both countries.

Sheep farms in England and Wales (data on Scotland are not available) are more diversified than in the United States. Seventy-two percent of the English and Welsh sheep farms also raise cattle, compared with 58% of US sheep farms.[13-15] These combined farms account for 81% of the sheep and 50% of the cattle in England and Wales, compared with 59% of the sheep and only 4.5% of the cattle in the United States.

The sheep industry is much larger and more dynamic in Great Britain than in the United States. In the past decade, milk quotas and related incentives have encouraged dairy farmers to diversify, and lamb and mutton exports to the European community have increased. As a result, the number of sheep farms and total sheep population have increased. The expansion of sheep production has intensified the traditional movement of breeding stock from the upland areas to the lowlands for crossbreeding schemes, a process known as stratification.[15] In addition, more extensive buying, selling, and movement of sheep occurs within Great Britain to arbitrage price differentials across different areas. The combination of an expanding industry and more movement and marketing may have contributed to the spread of scrapie in the sheep population.

Scrapie prevalence—Scrapie has been recognized in Great Britain since at least 1730.[16] An accurate measurement of the current prevalence is not available. In 1988, on the basis of a voluntary survey, Morgan[17] estimated that a third of the British flocks were affected, with the infected flocks scattered throughout Great Britain. Review of the government-sponsored Veterinary Investigation Diagnostic Analysis (VIDA) database from 1975 to 1990 revealed an increase from 63 to 328 in the number of annual scrapie diagnoses. The proportion of scrapie diagnoses relative to all mature sheep carcass and viscera submissions increased significantly ($P < 0.05$), from 0.041 to 0.250 for the same period. Great Britain currently operates a voluntary sheep health scheme, but only 6 flocks were monitored for scrapie in 1990.[18]

In the United States, scrapie was first reported in Michigan in 1947.[19] A Federal-State Cooperative Scrapie Eradication Program was begun in 1952, and confirmed scrapie-affected flocks were depopulated. In 1983, bloodline traceback and slaughter was adopted as an alternative. The number of identified positive flocks increased substan-

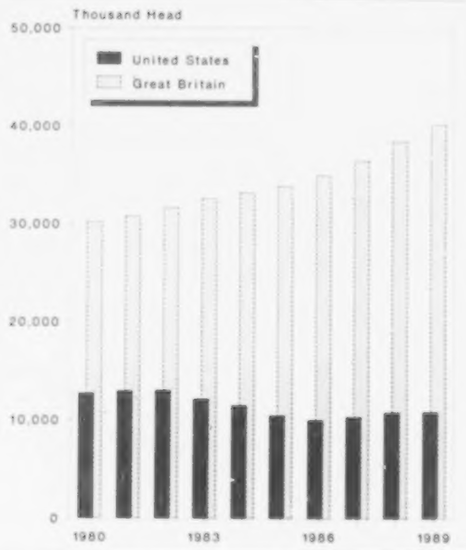

Figure 2—United States and Great Britain sheep inventories from 1980 to 1989. Sources: National Agricultural Statistical Service, USDA, 1980 to 1989, and the Ministry of Agriculture, Fisheries and Food, United Kingdom, 1980 to 1989.

Table 1—United States and Great Britain sheep inventories and operations by flock size in 1989. Sources: National Agricultural Statistical Service, USDA, 1980 to 1989, the Census of Agriculture, United States Department of Commerce, 1975 to 1989, and the Ministry of Agriculture, Fisheries and Food, United Kingdom, 1980 to 1989

% National inventories		Flock size	% Sheep operations	
Great Britain	United States	(No. of head)	Great Britain	United States
0.3	4.5	1 to 24	11.5	50
2.3	13.5	25 to 99	18.9	34
10.3	14.0	100 to 299	26.2	10
35.0	16.7	300 to 999	29.8	4
52.1	51.3	1000 +	13.6	2

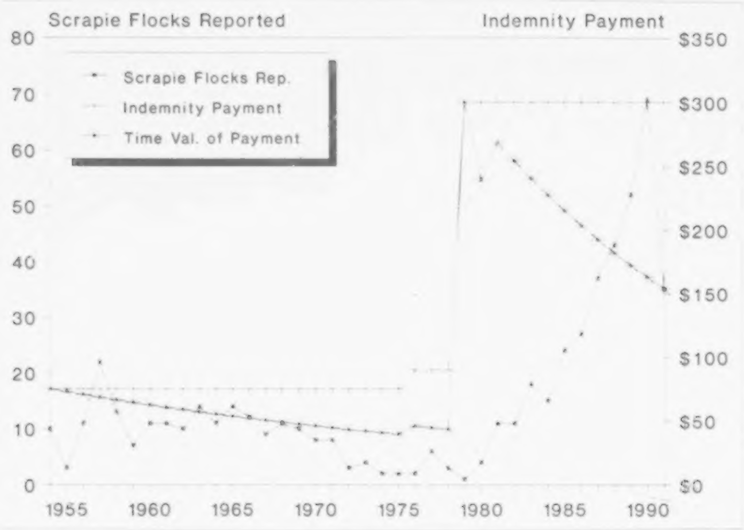

Figure 3—United States scrapie reporting and indemnity payments. Source: USDA-APHIS, 1955 to 1990.

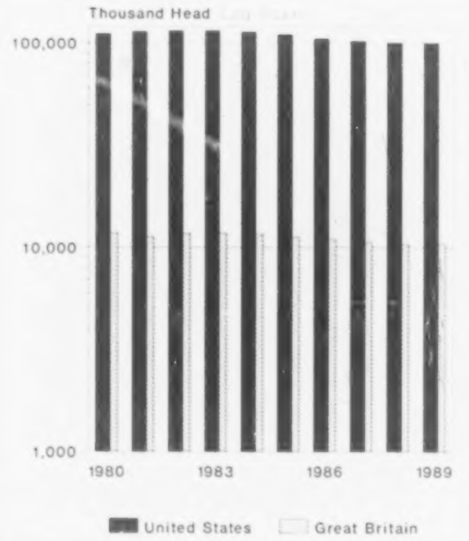

Figure 4—United States and Great Britain cattle inventories from 1980 to 1989. Sources: National Agricultural Statistical Service, USDA, 1980 to 1989, and the Ministry of Agriculture, Fisheries and Food, United Kingdom, 1980 to 1989.

tially in the 1980s. However, a sizeable increase in the indemnity payment in 1979 may explain much of the increase rather than a higher incidence of scrapie (Figure 3). Cumulative reporting of scrapie-infected flocks from 1980 to 1990 amounted to 7.5 of 1,000 flocks infected, with substantial interstate variation. A revised scrapie program is currently being formulated by a joint effort of the sheep industry and government animal health officials.

Although a database equivalent to VIDA does not exist in the United States, the Veterinary Medical Database (VMDB)[c] collects records from the veterinary colleges throughout the United States and can be used to tabulate descriptive statistics on case load and diagnoses. Since 1964, annual scrapie diagnoses recorded by the VMDB have varied from 0 to 9, with 8 diagnoses in 1989. For the five-year period from 1985 to 1989, scrapie diagnoses as a proportion of all sheep examined at the veterinary colleges increased significantly from 0.001 to 0.011 ($P = 0.01$). Diagnoses are disproportionately concentrated in the midwestern region.

Scrapie is endemic in the United States and Great Britain. Scrapie seems to be on the increase in Great Britain as the sheep population increases and sheep are actively moved between premises.[4] An active scrapie control program does not exist in Great Britain. The exact scrapie prevalence in the United States is uncertain, although the number of cases and incidence appears to be lower than in Great Britain, and a scrapie control program is ongoing.

Beef and dairy cattle industries—Both the US and GB cattle populations have decreased during the past decade. At just under 100 million head, the United States still maintains over 9 times more animals than Great Britain (Figure 4). Beef and dairy cattle herds in 1988 numbered 1,176,346 and 202,068 in the United States,[15] compared with 54,334 and 40,858 in Great Britain,[13] respectively.

The US cattle industry is segregated into distinct and separate beef and dairy components with little interaction. The US beef industry consists almost exclusively of beef breeds and beef crossbred cattle, and relies heavily on concentrate feeding for the fattening of steers and heifers for slaughter. More than 75% of all cattle slaughtered pass through a feedlot.

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[c] Weirich W. Veterinary Medical DataBase Program, Purdue University, West Lafayette, Ind: Unpublished data, 1990.

The GB beef and dairy industries are much more integrated. Roughly two thirds of slaughter cattle originate from dairy herds. Dairy crossbred calves are an important source of brood cows and steers for beef production. The beef industry is extensively managed; cattle are fattened on grass pasture over a longer period of time and relatively few animals enter feedlots.

The number of dairy cattle in both countries has decreased. The current US dairy population is 10.1 million head, compared with 2.6 million in Great Britain. Average herd size in the United States is larger than in Great Britain, with 24% of US dairy cattle in herds of 200 or more head, compared with only 10% of GB cattle. Dairy cows are culled at younger ages in the United States. Less than half (46%) of the US dairy cows are 4 years old or older,[d] compared with 70% of GB dairy cows. The average age of US dairy cows is 3.8 years, compared with 5.1 years in Great Britain.

Productivity in the US dairy industry continues to increase. The average dairy cow consumes 2.6 tonnes of concentrate feed per year and produces 6,461 liters of milk.[14] Dairy cattle are bred predominantly by artificial insemination, using dairy breed bulls. Surplus bull calves are sold for veal production.

Dairy productivity trends in Great Britain have declined in the last 10 years because of changes in the economic community's agricultural policies, including the imposition of milk quotas. Concentrate feeding has fallen by one half to about 1 tonne/head/yr. Average milk production per cow has also decreased from 5,076 liters in 1982 and 1983 to 4,923 liters in 1989.[20] Beef bulls are used as a regular part of dairy breeding programs. The sale of dairy crossbred animals (bulls and heifers) represents an important source of income for GB dairy farmers.

Differences in the GB and US beef and dairy cattle industries have direct implications for BSE. Feedlot steers in Great Britain have not had BSE, presumably because these cattle do not live long enough to show clinical signs of disease even if exposed. This suggests a low risk for US feedlot animals. The cases of BSE observed in beef herds are predominantly in purchased dairy crossbred cattle, exposed to meat and bone meal as calves on dairy farms prior to relocating to beef herds. The GB dairy cattle are exposed to meat and bone meal as calves and to dairy concentrate rations as adults. These dairy cows have a longer herd life and may not proceed as quickly to slaughter as in the United States. Some of the cull GB dairy cows enter the beef industry as suckling cows. An estimated 5 to 7% of all brood cows in beef herds are cull dairy cows.[e] If exposure has occurred, the longer age span increases the likelihood of developing clinical signs of BSE.

Slaughter industry—The US slaughter industry is more concentrated than that in Great Britain, with specialized single-species plants accounting for a higher proportion of total production. In 1989, eleven of the 4,500 US slaughter plants, each slaughtering more than 100,000 head, accounted for over 80% of the total lamb slaughter. Twenty-four plants, each slaughtering more than 3,000 head, accounted for over 80% of the total mature sheep slaughter.[21] In Great Britain, sheep slaughter is more dispersed among the 850 slaughter plants, with most plants accepting sheep, cattle, and swine as supplies and market conditions dictate.

In 1989, the US slaughter industry produced 10.48 million tonnes of beef and 157,900 tonnes of lamb and mutton,[22] compared with 880,000 tonnes of beef and 348,300 tonnes of lamb and mutton[b] in Great Britain, respectively. The GB mature sheep slaughter is 5 times higher than that in the United States, whereas the US cattle slaughter is over 12 times that in Great Britain.

The concentration of the US mature sheep slaughter industry suggests that raw materials for rendering may be amassed at several specific sites rather than dispersed throughout the country as in Great Britain. However, total cattle slaughter, in terms of tonnes of beef produced, is 66.4 times greater than the total sheep slaughter in the United States, compared with a ratio of only 2.5 in Great Britain.

Rendering industry—The US and GB rendering industries have moved from a batch process to a more efficient and less resource-intensive continuous process. The transition in the United States began in the early 1970s, with continuous processing now used in all but a few large poultry renderers. The shift in Great Britain occurred in the mid 1970s, with only about 30 small renderers still using the batch method today. The continuous process accounts for approximately three quarters of Great Britain's total output. A second major change in Great Britain was the virtual discontinuance of solvent extraction in the rendering process. A market acceptance of higher fat content allowed the phaseout by the early 1980s.[10] Solvent extraction was never practiced widely in the United States and was discontinued by most renderers more than 30 years ago.[21]

One segment of the GB rendering industry not typical in the United States is the knacker industry. Knackers specialize in the collection of dead, diseased, or injured animals not fit for human con-

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[d] Norman D. Animal Improvement Production Laboratory, Agricultural Research Service, USDA: Unpublished data, 1990.

[e] Barnes G. ADAS Livestock Services, Ministry of Agriculture, Fisheries and Food, Wolverhampton, United Kingdom: Personal communication, 1990.

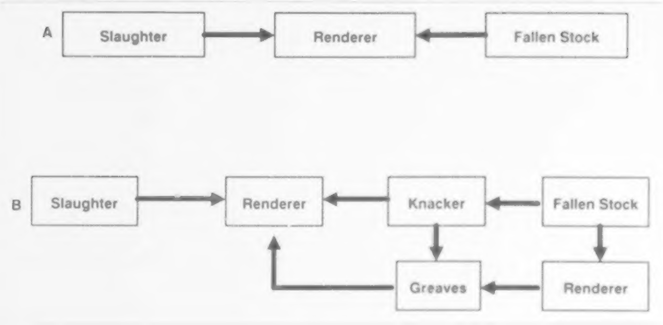

Figure 5—United States (A) and Great Britain (B) rendering industry structure.

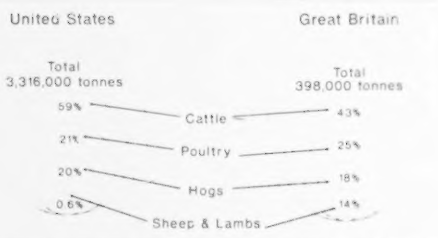

Figure 6—United States and Great Britain rendered animal protein estimated species composition in 1989. Source: USDA-APHIS, 1989.

sumption (Figure 5).[23] Operating throughout Great Britain, coverage has been efficient. Knackers, in concert with small renderers, produce a solid by-product called greaves by cooking the carcasses to remove the tallow. Greaves are sold as an intermediate product to larger renderers. In the United States, renderers handle the pickup of fallen stock; however, coverage is not as complete as in Great Britain except in areas of high livestock concentrations. Greaves are not manufactured in the United States. In Great Britain, raw materials (including greaves) are moved between renderers to a much greater extent than in the United States, contributing to homogeneity of the product.

Animal protein rendering production, excluding blood, feather, and fish meal, can be estimated on the basis of the total number and by-product yield of all species slaughtered. In the United States, animal protein production is estimated at 3.3 million tonnes versus 398,000 tonnes in Great Britain. Sheep slaughter contributes about 0.6% of the total rendered animal protein in the United States, compared with 14% in Great Britain (Figure 6). The rendered animal proteins are distributed into animal feeds, with approximately 13% entering cattle feed in the United States, compared with 10 to 20% in Great Britain prior to the ban on feeding of rendered animal proteins to ruminants in July, 1988.[24] The concentration of single species slaughter in the United States may create significant differences in the quantities of different raw materials to be rendered across the nation. However, the relative and absolute contribution of sheep raw materials in Great Britain greatly exceeds that in the United States.

Ruminant feed industry—Ruminant feed formulations in the United States and Great Britain are driven by least-cost considerations, subject to nutrient requirements. Although oilseed meals are the primary protein source in US feed formulations, constituents such as soybeans must be imported into Great Britain. Consequently, prior to the GB ban, the portion of all animal protein products used in feed as a percent of all protein products in feed was 6 to 7% more in Great Britain than in the United States. Additional usage of animal proteins was tempered in Great Britain by palatability considerations.

In July 1988, the feeding of ruminant-based protein products to cattle was disallowed. Prior to the ban, important differences existed between the United States and Great Britain as to the amounts and types of cattle feeds that contained meat and bone meal. In the United States, meat and bone meal is routinely incorporated into adult cattle rations. However, it is not believed to be incorporated into US calf starter rations, attributable in part to palatability concerns as well as an abundance of plant-based proteins. In Great Britain, calves were typically fed 25 kg of calf starter with meat and bone meal, blood meal, or a combination thereof, accounting for up to 4% of the formulation. This amounted to roughly 1 kg of meat and bone meal over a 12-week period beginning around 1 month of age.

Qualitative risk assessment for the United States

A comparison of the United States and Great Britain revealed tremendous differences in the size, structure, and conduct of the sheep, beef, and dairy industries (Table 2). Great Britain has a large and active sheep industry but a small cattle industry, whereas the United States has a large cattle industry and a small sheep industry. The relative magnitude of these two industries in each country has a tremendous impact on comparisons of the slaughter and rendering industries. Sheep slaughter and the resultant proportion of mature sheep offal to

Table 2—United States and Great Britain comparison of sheep and cattle populations from 1980 to 1989. Sources: National Agricultural Statistical Service, USDA, 1980 to 1989, and the Ministry of Agriculture, Fisheries and Food, United Kingdom, 1980 to 1989

	Great Britain		United States		Great Britain United States	
Ratio	1980	1989	1980	1989	1980	1989
All sheep to all cattle	2.6	3.9	0.11	0.11	23.6	35.5
All sheep to all dairy cattle	10.2	15.6	1.2	1.1	8.5	14.2
All sheep >1 year old to all cattle	1.3	1.9	0.08	0.08	16.3	23.8
All sheep > 1 year old to all adult cows	3.7	5.2	0.19	0.17	19.5	30.6
All sheep > 1 year old to all dairy cows	5.3	7.7	0.83	0.74	6.4	10.4

total rendered protein products produced are substantially larger in Great Britain than in the United States.

However, major differences notwithstanding, the United States has all of the necessary factors for BSE; that is, the presence of scrapie in the sheep population, similar rendering technology allowing for the survival of the scrapie agent, and inclusion of meat and bone meal in cattle concentrate feeds. Consequently, evaluation of the relative risk of BSE in the United States utilizes the "effective dose" concept to understand cattle exposure to the scrapie agent.

Effective dose is defined as the amount of exposure necessary to cause clinical signs during an infected animal's lifetime. The incubation period of scrapie is inversely related to the exposure dose.[25] Low exposures are associated with protracted incubation times. The effective dose of the scrapie agent for BSE is hypothesized to be reached when clinical signs begin to appear within the lifespan of the average cow.

In Great Britain, the effective dose concept[10] assumed that the scrapie agent survived the rendering process and was incorporated into cattle feeds for decades prior to the recognition of BSE. Apparently, the appearance of BSE in the mid-1980s resulted from the interaction of at least 3 separate trends: adoption of a continuous rendering process and the cessation of solvent extraction by the rendering industry, the increase in the sheep population relative to cattle populations as the source of raw materials for rendering, and the apparent increase in scrapie along with the active sale and movement of sheep as the overall sheep population grew. The net effect of all of these events was an increase in the exposure dose of scrapie to cattle.

Evaluation of the US risk of BSE suggests that dairy cattle have the greatest risk of exposure to the scrapie agent and development of the clinical disease. Beef brood cows are fed low amounts of concentrates. Feedlot animals typically consume much higher amounts of concentrates but are slaughtered long before the clinical signs of BSE would be evident. A worst-case scenario can be hypothesized as all meat and bone meal from mature sheep being incorporated into dairy concentrate feeds only. For this scenario, a ratio can be calculated to quantify the relative exposure to the scrapie agent by dividing the kilograms of concentrates fed to dairy cattle by the kilograms of mature sheep meat and bone meal produced. The ratio in the United States is 34,760:1, compared with 778:1 for Great Britain. Therefore, the worst-case concentration of scrapie agent in US dairy feeds is 45 times less than the worst-case concentration in Great Britain. After taking into consideration the average concentrate consumption of US and GB dairy cattle, the average US cow would consume 80 g of mature sheep meat and bone meal per year, compared with 1.6 kg in Great Britain. Furthermore, the lack of incorporation of meat and bone meal into calf starter feeds in the United States suggests a later exposure in the average animal's life.

The lower exposure dose, the later time of exposure, and the shorter average lifespan of the US dairy cows decrease the likelihood of seeing clinical signs even if the cattle become infected. Consequently, US dairy cattle appear to be at much lower risk for development of BSE than GB dairy cattle, even under the worst-case scenario.

The role of risk assessment

Two brief risk assessments for BSE in the United States have been done, each targeting a different audience.[23,†] On the basis of our qualitative analysis, we reached conclusions similar to those reported by others, that is, the potential risk of a BSE epizootic in the United States on the scale of Great Britain's experience is small.

Although the comparison of risk factors does not identify a broad national risk for a BSE epizootic in the United States, wide regional variations in risk may result for specific areas. The development of sporadic cases of BSE cannot be ruled out. Moreover, further evidence of an increase in scrapie incidence or increased incorporation of meat and bone meal into calf starter rations would necessitate a reconsideration of the risk. Quantitative risk analyses are underway in the USDA to further define high-risk practices and geographic areas within the United States.

Concerns have been raised about the potential of BSE in other countries[26-28]; however, no other formalized national risk assessments have been published. The risk assessment described in this report addresses the aggregate national animal health and is necessarily qualitative, that is, comparing industry structure, demographics, and overall production statistics between the United States and Great Britain. Quantitative risk assessments,

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[†] Marsh RF. Risk assessment on the possible occurrence of bovine spongiform encephalopathy in the United States. Presented at the Seminar on Spongiform Encephalopathies organized by the European Commission, Nov 12-14, 1990.

such as the building of models, complement qualitative risk assessment and allow for more specific definition of areas or practices associated with the highest risks.

The ultimate use of the BSE risk assessment is twofold: risk communication and risk management. Risk communication involves educating those potentially affected by BSE so that perceptions of risk can be anticipated and addressed.[29] Risk management directs resources toward the critical points of highest risk of BSE identified through the risk analysis and prepares contingency plans in the event that BSE is identified within the United States.

The USDA-APHIS Veterinary Services is working with other federal and state agencies on risk communication and risk resolution. An extensive education program is underway to acquaint veterinarians with clinical signs of BSE. At the same time, an active surveillance program is being maintained for BSE suspects. Surveillance efforts are being intensified in the areas identified as high risk by the quantitative assessment. The surveillance hinges on the examination of brains from cattle with suspicious neurologic signs, because no diagnostic tests for live animals are currently available. In addition, contingency planning is underway to ensure preparedness in the event of BSE diagnosis.

Private practitioners are a critical component for the early identification of BSE suspects. Veterinarians that observe cattle with clinical signs compatible with BSE are encouraged to contact their nearest state or federal veterinarians for diagnostic support.

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A71-2

December 15, 1991, Volume 199, Number 12

JOURNAL

OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

Oregon

Patty Bratsberg

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 199 December 15, 1991 No. 12
JAVMA 199 (12) 1673-1816 (1991)
ISSN 0003-1488

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SUBSCRIPTIONS: For one year: members $35; others $70 in the United States and possessions; $90 in foreign countries. Single copies: $6.00 in the United States and possessions; $8.00 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1991 by the AVMA.

ADDRESS CHANGE: Send new address (and moving date) 45 days ahead. Include old address as it appeared on previous issues (if possible send label).

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BPA

Hepatoencephalopathy and hypocalcemia in a miniature horse mare

A pregnant, miniature horse mare had clinical signs of hepatoencephalopathy and concurrent hypocalcemia. The signs included dullness, inappetence, blindness, head pressing, weakness, muscle fasiculations, uveitis, and urinary incontinence. Hepatic dysfunction and hypocalcemia were confirmed by serum biochemical analysis. The mare was treated successfully with a continuous infusion of Ringer solution, calcium gluconate, dextrose, B-complex vitamins, sodium ampicillin, and flunixin meglumine; topical administration of ophthalmic ointments; and decompression of the urinary bladder. Histologic examination of a liver biopsy specimen revealed acute hepatic necrosis, which likely was associated with administration of a vaccine of equine origin 2 months earlier.—W. K. Scarratt et al (J Am Vet Med Assoc 1991; 199:1754-1756). Key words: equine species; brain; hypocalcemia; liver; vaccination.

Salmonella typhimurium abscess as a postoperative complication in a horse with colic

An 11-year-old, 430-kg foxtrotter stallion was referred for evaluation of colic. A right-sided inguinal hernia was diagnosed. At exploratory laparotomy, the ileum was found to be herniated through the right inguinal canal. Compromised small intestine was resected, jejunocecal anastomosis was performed, and the horse was castrated. Three days after surgery, the stallion would not bear weight on the left hind limb. The musculature of the left thigh region became swollen. Aspiration of the left thigh region yielded serosanguineous fluid from which *Salmonella typhimurium* was isolated. Ultrasonography of the left thigh revealed multiple hypoechoic areas suggestive of abscess. The left medial thigh region was surgically incised, and a large abscess was drained. Bacteriologic culture of feces yielded *S typhimurium*. The owner elected to have the horse euthanatized. —A. T. Blikslager et al (J Am Vet Med Assoc 1991;199:1757-1759). Key words: equine species; abscess; colic; *Salmonella* spp.

Spermatozoal head defect as a cause of infertility in a stallion

A 9-year-old Arabian stallion with a 3-year history of infertility was evaluated for breeding soundness. Both testes were small. Ultrasonography revealed a small amount of free fluid between the tunics of both testes. Results of cytologic examination of the fluid were unremarkable. On semen examination, progressive motility was 10%, and total number of spermatozoa in the ejaculate was 6.6×10^9, of which 92% were abnormal. Predominant abnormalities were head defects (75%): 57% of the heads had single or multiple vacuoles, and 60% also had midpiece swelling or bending.—J. P. Held et al (J Am Vet Med Assoc 1991;199:1760-1761). Key words: equine species; infertility; spermatozoa.

Medical and surgical management of small-colon impaction in horses: 28 cases (1984-1989)

Impaction of the small colon with digesta was diagnosed in 28 horses between 1984 and 1989; 20 horses were admitted during the winter months. Diagnosis of small-colon impaction was made in 21 horses by palpation per rectum, and in 7 horses at exploratory celiotomy. Ten horses were treated medically, and 18 horses were treated surgically. Medical treatment included IV administered fluids and analgesics and orally administered laxatives, lubricants, and analgesics. Surgical treatment included "high enema" under anesthesia, large-colon enterotomy, and small-colon resection. Horses that were treated surgically were more likely to have abdominal distention than were those that responded to medical treatment ($P < 0.025$). Signs of greater degree of abdominal pain and higher heart rate were seen in horses treated surgically. Duration of hospitalization was less in horses treated medically ($P < 0.025$). All horses that were treated medically survived, and 7 of the horses treated surgically were alive at follow-up evaluation. Long-term survival was higher for horses treated medically ($P < 0.025$). Postoperative complications included fever and diarrhea. Early and aggressive medical management of horses with impaction of the small colon is recommended.—A. J. Ruggles and M. W. Ross (J Am Vet Med Assoc 1991; 199:1762-1766). Key words: equine species; colon; obstruction, intestinal.

Primary hyperparathyroidism in cats: Seven cases (1984-1989)

The clinical signs, serum biochemical abnormalities, treatment, and histologic findings from 7 cats with primary hyperparathyroidism were evaluated. The cats were 8 to 15 years old, and the most common clinical signs were anorexia and lethargy. Each cat was persistently hypercalcemic prior to treatment. Five of the cats had a parathyroid adenoma surgically removed, 1 had bilateral cystadenomas surgically removed, and 1 had a parathyroid carcinoma diagnosed at necropsy. Two of the 6 cats that had surgery became severely hypocalcemic afterward, but responded to orally administered vitamin D. This report confirms that primary hyperparathyroidism develops in cats and that the hypercalcemia in each cat was a serendipitous finding on a routine serum biochemical profile. Once hypercalcemia is confirmed, primary hyperparathyroidism should be included in the differential diagnosis.—A. J. Kallet et al (J Am Vet Med Assoc 1991;199:1767-1771). Key words: feline species; hyperparathyroidism, primary.

Perineal urinary bladder diverticulum resulting in partial urinary obstruction in a rhesus monkey

A 16-year-old rhesus monkey with perineal swelling and urinary obstruction was found to have a congenital urinary bladder diverticulum. Because the diverticulum was located at the trigone, its distention partially obstructed the urethra, resulting in incomplete voiding. The diverticulum was resected and did not redevelop.—D. J. Gaertner et al (J Am Vet Med Assoc 1991;199:1772-1774). Key words: monkeys; urinary obstruction; urinary bladder diverticulum.

Myxosarcoma in a Sinaloan milksnake

A 2-year-old Sinaloan milksnake was examined because of a 1-cm mass attached to the lateral wall of the coelom. A diagnosis of myxosarcoma was made on the basis of histologic features and special staining characteristics.—P. J. Ewing et al (J Am Vet Med Assoc 1991;199:1775-1776). Key words: snakes; neoplasia.

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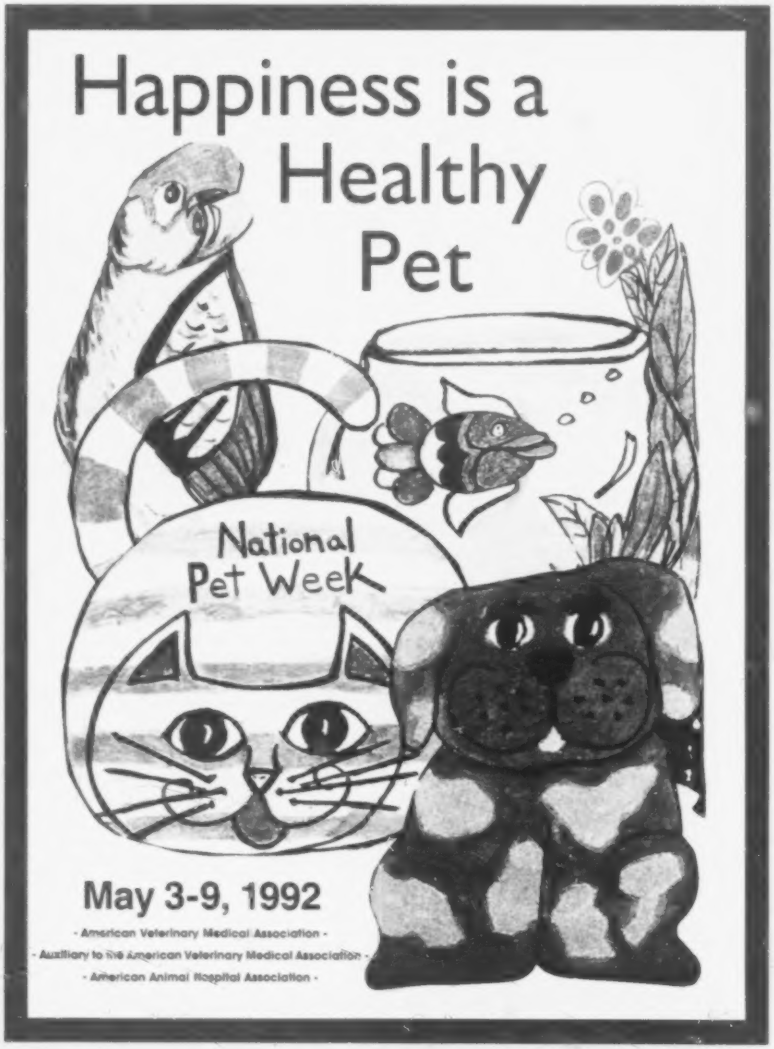
January 1, 1992, Volume 200, Number 1

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION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OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 200 January 1, 1992 No. 1
JAVMA 200 (1) 1-128 (1992)
ISSN 0003-1488

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Characteristics of US veterinarians specializing in preventive medicine

William D. Hueston, DVM, PhD

The PEW Report[1] focused attention on preventive medicine as an integral component of clinical veterinary practice and as a separate field of specialization. The term veterinary preventive medicine, when used to identify a separate field of specialization, includes the disciplines of epidemiology and public health as well as the public practice categories of regulatory, extension, and military medicine. According to the PEW findings, the importance of veterinary preventive medicine will continue to expand although veterinary college curricula are not meeting the existing demand.[2]

Characterizations of veterinary specialties in the United States have followed the American Veterinary Medical Association (AVMA) membership codes[3] for professional activity, employment function, and type of employer. Most of the analyses of job functions, salaries, and employment opportunities have grouped all nonclinical practice veterinarians by type of employer regardless of professional activity or employment function.[4]

The purposes of the survey reported here were to describe the demographics, employment status, and salaries of veterinarians specializing in preventive medicine. Associations between employment characteristics and board certification by the American College of Veterinary Preventive Medicine (ACVPM) were quantified. Diplomates of the ACVPM were asked additional questions concerning the importance of board certification to their careers.

Survey

A two-page, 18-item questionnaire was developed[5] to address employment characteristics and ACVPM certification status of veterinarians involved in preventive medicine. The questionnaire was designed to be self-administered and self-coding. Opportunities were provided for additional comments.

The survey sample was selected from two sources. First, all nonretired diplomates of the ACVPM (n = 354) were included. Second, a random sample of 532 names was selected from the AVMA membership list of 1,066 nondiplomate veterinarians with professional activity codes 30, 31, 36, 43, 50, or 91, corresponding to veterinary public health, veterinary preventive medicine, regulatory veterinary medicine, extension, military veterinary service, or epidemiology, respectively. The activity codes describe work reported by the veterinarians. Each AVMA member is allowed to identify up to three activity areas. Veterinarians listing employer type as retired were excluded. The sample of nondiplomates was larger than the sample of diplomates (ratio of 1.5:1) to compensate for an expected higher response rate among diplomates. The sample selection from the AVMA membership list was accomplished with a microcomputer random number generator.[6]

The questionnaire was mailed to the 886 veterinarians in January, 1990 following a modified total design method.[7] The first mailing included a cover letter, the questionnaire, and a pre-addressed, stamped, return envelope. The second mailing, mailed exactly 1 week later, consisted of a postcard reminder. Both mailings were sent with first-class postage.

The data from all respondents were entered into a microcomputer data base.[5] Analyses included descriptive statistics, χ^2 tests for differences between proportions, one-way analysis of variance, and multiple linear regressions, using a microcomputer statistical analysis package.[5] Unless otherwise noted, $P < 0.05$ was accepted as the level of significance for all statistical analyses. The 95% confidence intervals for selected regression coefficients were included to facilitate interpretation. Comments were summarized as the percentage of respondents commenting rather than the percentage of comments, because each respondent could provide multiple comments.

Dr. Hueston's address is 612 Boulder Circle, Fort Collins, CO 80524.

Supported by the American College of Veterinary Preventive Medicine.

The author thanks Dr. Pamela J. Hand for technical assistance.

Presented to the Board of Councilors, American College of Veterinary Preventive Medicine, at the AVMA annual meeting in San Antonio, Tex, July 23, 1990.

Survey results

Response rates—A total of 647 responses were received from the 886 veterinarians surveyed. After adjusting for 11 undeliverable questionnaires, deaths, or ineligibles, the corrected overall response rate was 73.9%. The response rate of ACVPM diplomates (83.5%) was significantly higher than nondiplomates (67%). Half of the responses were received within 9 days after the first mailing. The response time did not differ between diplomates and nondiplomates.

A total of 577 respondents (252 ACVPM diplomates and 325 nondiplomates; 89.2%) reported full-time employment in veterinary medicine. Respondents with less than full-time employment (ie, part-time, retired, unemployed, and graduate students) were excluded from the subsequent analyses. In addition, some respondents chose not to answer specific items, particularly the salary questions of which 11 of 577 or 1.9% were left blank.

Demographics—Females accounted for 10.3% of the respondents. Although the gender distribution of the 886 veterinarians in the original mailing was not known, a significant difference existed between the overall gender distribution of respondents: 3.6% females among the diplomates versus 15.5% females among the nondiplomates. The proportion of female diplomate respondents increased significantly over time when diplomates were stratified by year of ACVPM board certification (χ^2 for trend analysis). Only 1.2% of the responding diplomates certified before 1981 were female, compared with 2.6% of diplomates certified between 1981 and 1985, and 11.7% of the diplomates certified since 1985.

Overall experience (years since graduation from veterinary college) averaged 19.9 years. Diplomates had significantly more experience (mean, 22.3 years; median, 22 years) than nondiplomates (mean, 18.1 years; median, 16 years).

Advanced degrees, in addition to the veterinary degree, were reported by 55.6% of the respondents (master's 45.9% and doctorate 9.7%). Diplomates had significantly more additional degrees. Seventy-three percent of the diplomates had master's degrees and 14.3% had doctorates vs 24.6% and 6.2% of the nondiplomates, respectively.

Specialty board certification other than ACVPM was reported by 9.1% of the respondents. Diplomates of ACVPM were significantly more likely to have other board certifications (14.9%) than nondiplomates (4.5%).

Employment status—Most of the respondents were employed by government, with 31.2% military, 28.6% other federal employees, and 20.5% state or local government. College or university employers accounted for another 13.3%. The remaining respondents listed private practice (2.8%), industry (3.6%), or other employers. Board certification in ACVPM was significantly associated with employer. Diplomates were more likely to be employed in the military, industry, university, or private practice than nondiplomates. Nondiplomates were more likely to be other federal, state, or local employees.

Veterinarians involved in preventive medicine averaged 35.4% of their time in administrative tasks; 10.3% in research-related activities; 7.7% teaching or preparing to teach; 6.3% in nonresearch field investigations or surveys; 6.3% practicing clinical veterinary medicine; 25.9% in regulatory or inspection activities; 2.5% in diagnostic laboratory work; and 5.5% in other activities. Diplomates reported significantly greater amounts of time in administrative tasks, research, teaching, and other activities such as consulting. Nondiplomates spent significantly more time in regulatory and inspection activities.

The respondents perceived their primary function as protecting the public health (43.9%) and protecting animal industry (20.7%). The perceptions were significantly different between diplomates and nondiplomates. Diplomates were more likely to associate teaching, research, meeting the needs of industrial employers, or reducing morbidity or mortality in individual animals with their primary function. Nondiplomates more frequently identified protecting animal industry as their primary function.

Salaries—The mean annual salary from the respondents' primary employment was $49,456 with a range of $15,000 to $145,000. Gender, advanced degrees, years of experience, employer, and ACVPM board certification were each associated with significant salary differences in univariate analyses. Salaries were significantly higher for males than females. Advanced degrees and experience were associated with higher salaries. Two sets of employers were clearly identifiable by salaries. Industry- and university-employed veterinarians had higher salaries than government, private practice, and others. Diplomates had higher salaries than nondiplomates.

To account for confounding, a multiple regression analysis was performed incorporating all of these variables. Experience was a continuous variable indicating years since graduation from veterinary college. Advanced degrees were treated as two dichotomous dummy variables: master's degree (yes/no), and doctorate (yes/no). The remaining variables also were handled as dichotomous dummy variables. Employer was coded as industry or university vs all others.

All of the variables except gender were significant predictors of primary income in the multiple regression. Experience explained the greatest amount of the difference in salary, followed by doctorate degree, board certification, employer, and master's degree (Table 1).

Table 1—Regression for predictors of salary from primary employment

Source of variation	Regression coefficient	95% CI		Partial *F* test
		lower	upper	
Experience (per year)	$549	$451	$648	119.4
Doctorate degree (yes = 1, no = 0)	$7,728	$4,032	$11,424	16.8
ACVPM board certification (yes = 1, no = 0)	$4,172	$1,604	$6,740	10.1
Employer (industry/ university = 1, other = 0)	$4,745	$1,705	$7,785	9.4
Master's degree (yes = 1, no = 0)	$3,905	$1,371	$6,440	9.2

Primary Salary = $33,232 + $549 (years of experience) + $7,728 (if doctorate) + $4,172 (if ACVPM diplomate) + $4,745 (if employed by industry or university) + $3,905 (if master's degree).

CI = Confidence interval.

Additional income from secondary employment averaged $1,827; however, 83.4% of the respondents reported no income in addition to the salary from their primary employer. Using the multiple regression model, advanced education and gender were not significant factors in predicting additional income. In the final model, employer accounted for most of the variation, followed by experience and board certification. University- and industry-employed veterinarians had more additional income (mean of $1,987) than the others. Each year of experience was associated with an average of $67 more additional annual income. Board certification in ACVPM accounted for another $1,427 of additional annual income.

Importance of board certification—Most of the ACVPM diplomates (72.4%) believed that board certification helped their careers; however, less than half (41.6%) believed that board certification increased their earning power. Most of the diplomates (70.6%) expressed an interest in seeing increased benefits associated with diplomate status. A total of 203 suggestions for increased benefits were provided by 135 diplomates. The most frequently mentioned additional benefits included: encourage board certification as a job requirement (29.6%); pressure employers for more recognition of board certification (28.1%); more public relations to increase board stature (17.8%); more continuing education and scientific programs (17.8%); and more information on job opportunities (15.6%).

Among the nondiplomates, less than half (44.8%) responded that they have considered taking the ACVPM certification examination. A total of 208 reasons for not considering ACVPM board certification were provided by 190 nondiplomates. The most frequently cited reasons included: do not know about the board or need more information (18.9%); do not see any benefits or advantages to board certification (15.3%); not applicable to present job (14.7%); too busy (12.1%); too old (10%); or not interested (10%).

Interpretation of survey results

The high response rate suggested that the survey addressed concerns held by many veterinarians involved in preventive medicine. The reason for the paucity of private practitioners in the sample was unclear. The AVMA activity codes may be presented in such a way that the practice codes (10-19) are seen to be mutually exclusive of the other codes. Alternatively, private practitioners may not perceive a part of their clinical practice activity as preventive medicine or public health. Within the ACVPM diplomates responding, the private practitioners probably represent second careers for veterinarians after careers in public practice.

The veterinarians responding to this survey were primarily public practitioners employed by government or universities. The proportion of respondents with additional education beyond the veterinary degree was surprisingly high, suggesting that additional education was important to their job responsibilities. The distribution of work activities suggested various responsibilities, although administrative and regulatory activities accounted for more than a quarter of the average work week.

Mean salaries for veterinarians involved in preventive medicine appeared to be similar to the mean income for veterinarians in private practice and public practice as estimated in the AVMA biennial economic survey of 1987.[4] Total income (primary salary plus additional annual income) for the preventive medicine respondents in private practice was $53,214 (n = 14) compared with $51,138 (n = 552) for public practice respondents, whereas the AVMA survey figure for all veterinarians in private practice was $52,643 compared with $51,995 for all veterinarians not in private practice.

Conversely, the multiple regression model predicted starting salaries $10,000 higher than the AVMA statistics for new graduates. The model estimated a starting salary of $33,233 for a new graduate entering the preventive medicine field with no advanced degrees, no board certification, and employed in private practice, military, or other federal, state, or local government. The starting salary for preventive medicine practitioners in universities or industry would be even higher. The annual AVMA statistics on new graduates reported actual starting salaries for 1989 of $24,742 for private practice and $23,645 for nonprivate practice.[8] Unfortunately, the figures are not directly comparable, because the nonprivate practice includes both university and industry employment and may include individuals pursuing advanced education.

The inability of the multiple regression model to accurately predict starting salaries may also be attributed to the manner in which veterinarians enter preventive medicine practice. New graduates overwhelmingly chose private practice (78%) or advanced study (15.2%) as their first jobs. Only 3.6% enter the public practice areas of university, military, other federal, state, or local government, or industry, where preventive medicine is more likely to be a major recognized job function.[9] The timing of the survey, late winter, assured that no new graduates (0 experience) would be surveyed; however, only 32 (5.5%) of the full-time employed respondents reported between 1 and 5 years of experience. The relative lack of less experienced veterinarians reporting preventive medicine activities paralleled the observation that many veterinarians enter preventive medicine, particularly public preventive medicine practice, after changes in career direction or completion of advanced education.

Reports from the AVMA biennial economic survey confirm the positive correlation between experience and salary.[10] Another report from the same survey provided additional evidence for two distinct income clusters within public veterinary practice. The college/university, industry/commerce, and other/not-for-profit cluster had higher mean salaries ($50,739, $65,321, and $51,747, respectively) than the federal government, state or local government, and armed forces ($45,477, $45,500, and $43,365, respectively).[4] The difference in incomes between the clusters was roughly equivalent to the difference predicted by the multiple regression analysis, $6,658.

The characteristics of ACVPM diplomates were different from those of nondiplomates. The diplomates were more experienced, had more education, and were more likely to be male. Interestingly, the difference in experience (4.1 years) was close to the minimal experience currently required for eligibility for the ACVPM Boards (6 years experience, or graduate training plus experience equaling 6 years). If the nonboard-eligible respondents (5 years experience or less) are removed from the nondiplomates, the mean experience level of diplomates and nondiplomates differed by <1 year. Gender and education differences also were diminished. In part, the gender differences reflected the changing demographics of the veterinary profession. The proportion of women being certified in ACVPM has increased significantly through the past decade, paralleling the overall increase in women entering the profession.

The differences in diplomates' perception of their primary function related principally to differences in their primary employer. The differences in time allotted to various activities also reflected the difference in employers and the difference in experience. As experience increased, time allotted to administrative duties increased significantly.

The ACVPM diplomates had higher salaries than nondiplomates. Analysis of a survey of laboratory animal veterinarians revealed a salary difference of $11,188 when American College of Laboratory Animal Medicine (ACLAM) board-certified veterinarians were compared to non-board-certified members of the American Society of Laboratory Animal Practitioners (ASLAP).[a] This difference was slightly higher than the unadjusted $9,823 difference between ACVPM diplomates and nondiplomates. After adjusting by the multiple regression model for the differences in experience, advanced education, and employer, the ACVPM diplomates made an average of $4,172 more in annual salary from their primary employers and additional income of $1,427 more than nondiplomates. An adjustment for potential confounders of the salary differences was not reported in the ACLAM/ASLAP study even though the report noted salary differences for experience, gender, employer, and advanced education.

Caution must be exercised in interpreting the results of these analyses. The significant difference in salary did not necessarily prove a cause-and-effect relationship between board certification and income. Less than half of the ACVPM diplomates believed that the board certification had increased their earning power, although most diplomates believed that board certification had helped their careers. Board certification may be a prerequisite for certain types of advancement. The data collected in this survey did not allow the question of causality to be answered conclusively, although anecdotal evidence from the comments suggests that board certification is a prerequisite for promotion in the military.

A survey of military and other federal veterinarians corroborated the perceived importance of ACVPM board certification for preventive medicine careers in the federal government.[b] When asked their opinion of the value of ACVPM diplomate status to their career, the most frequently selected response was high on a 6-point scale ranging from none to very high. Respondents also strongly recommended that colleagues pursue diplomate status.

Another interesting finding was the relationship between employer and additional income from secondary sources. Many governmental positions (especially military and federal government) disallow outside professional activities, whereas private practice employers, universities, and industry allow and even encourage outside consultation. Only 10.3% of federal and 5.0% of military employees acknowledged additional income, compared with 22% of state employees, 33.3% of industry employees, 40.3% of university employees, and 50% of the private practitioners. Therefore, the disparity between the total income of military and federal preventive medicine practitioners and the income of veterinarians working for other employers was heightened, especially with regard to the high end of the salary scale. The highest salaries reported in this survey by university, industry, private practice, military, other federal government, and state and local government were $122,000, $145,000, $105,000, $84,000, $82,500, and $93,000, respectively.

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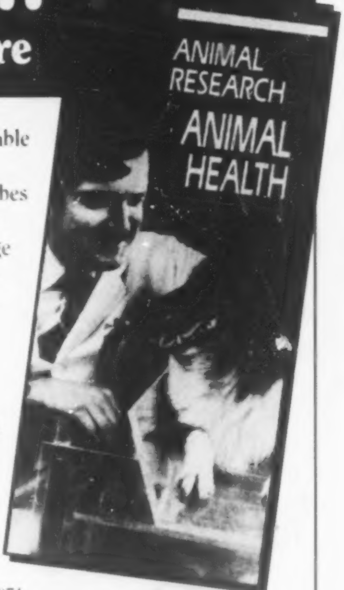

January 15, 1992, Volume 200, Number 2

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

The Group

Lynn Ferris

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 200 January 15, 1992 No. 2
JAVMA 200 (2) 129-248 (1992)
ISSN 0003-1488

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SUBSCRIPTIONS: For one year: members $50; others $100 in the United States and possessions, $120 in foreign countries. Single copies: $6.00 in the United States and possessions, $8.00 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

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Economic Note

Employment of 1991 male and female graduates of US veterinary medical colleges

On the basis of the 1991 AVMA survey of 1,318 graduates of US veterinary medical colleges, it was estimated that 75% of the graduates accepted positions as private practice employees at a mean annual salary of $27,829, an increase of 5% from 1990.[1] This report describes in greater detail the employment choices of 1991 male and female veterinary medical college graduates.

Type of Employment

Of the 1,318 graduates responding to the 1991 AVMA survey, 56% were women and 44% were men. Excluding graduates entering advance study programs (graduate degrees, internships, or residencies), 76% of the women received one or more offers of employment, compared with 90% of the men (Table 1).

*Table 1—Employment offers to male and female veterinary medical college graduates, 1991**

	Male (n = 514)	Female (n = 617)	Total (n = 1,131)
Received ≥1 offer (%)	90	76	82
Received no offers (%)	10	24	18

*Excludes graduates entering advanced study programs

Regarding graduates who had accepted employment (69%), 96% of the women and 99% of the men would work full time. Of the 23 responding graduates indicating part-time employment, 17 were women.

Table 2—Employment of male and female veterinary medical college graduates, 1991

	Male (n = 398)	Female (n = 389)
Large animal exclusive (%)	3.3	1.0
Large animal predominant (%)	15.3	4.1
Mixed animal (%)	17.6	8.7
Small animal predominant (%)	9.0	11.1
Small animal exclusive (%)	30.2	43.4
Equine predominant (%)	5.8	3.6
University (research, teaching) (%)	1.8	0.2
Federal government (%)	...	0.5
Military service (%)	1.8	0.5
State/local government (%)	...	...
Industry/commercial business (%)	0.5	0.3
Advanced study (%)	12.1	22.1
Self employed (%)	1.8	1.0
Other employment (%)	1.0	2.8

Table 3—Fringe Benefits received by male and female full-time employed graduates, 1991

	Male (n = 398)	Female (n = 389)	Total (n = 787)
Life insurance (%)	28	20	23
Medical/hospital plan (%)	65	66	65
Dental plan (%)	13	13	13
Pension plan (%)	12	8	10
Profit sharing plan (%)	18	14	16
Disability insurance (%)	34	32	33
Liability insurance (%)	68	63	66
Association dues (%)	51	51	51
Continuing education (%)	70	68	69
Annual vacation leave (%)	78	79	79
Sick leave (%)	45	49	47
Housing/apartment (%)	7	5	6

The distribution of female and male graduates was determined according to type of full-time employment (Table 2). Approximately 72% of female graduates accepting full-time employment took positions as employees in private practice. This compares with 81% of male graduates. Twenty-two percent of the women, compared with 12% of the men, began advanced study programs.

Starting Salaries

Graduates were asked to report their starting salary (on an annual basis) for full-time employment. The mean female graduate's starting salary as a private practice employee was $27,231, up 5.2% from 1990.[2] (Fig 1). The mean male graduate's starting salary as a private practice employee was $28,060, up 3.6% from 1990.

Prepared by J. Karl Wise, PhD, Director, AVMA Center for Information Management

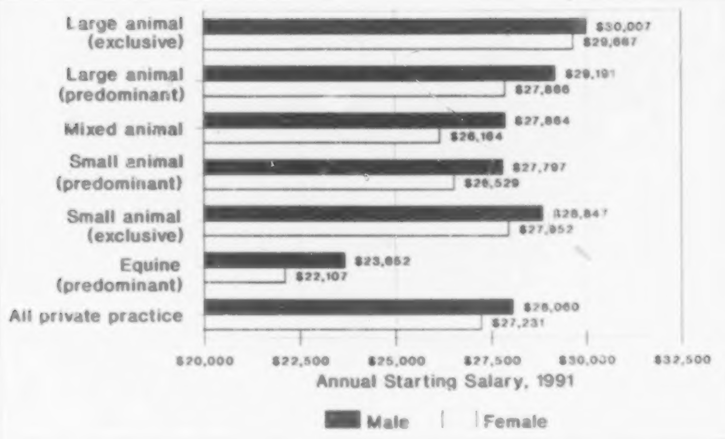

Figure 1—Mean starting salary by type of practice for male and female veterinary medical college graduates, 1991.

Table 4—Personal characteristics of male and female veterinary medical college graduates, 1991

	Male	Female	Total
Average age (years)	27.4	27.6	27.5
Marital status			
Single (%)	59	66	63
Married (%)	39	30	34
Divorced (%)	2	4	3
Graduates with children (%)	13	5	8

The 1991 mean starting salary for females was $829 (3%) less than the 1991 mean starting salary for males.

The survey did not secure information on each graduate's responsibilities or hours worked in the new job. Thus, it is not possible to draw conclusions from these survey data about reasons associated with varying salary levels between male and female graduates.

Fringe Benefits

All graduates were asked to indicate which of 12 fringe benefits would be provided by their new employer. Of male and female graduates who accepted full-time employment, the percentage receiving each of the fringe benefits is in Table 3. The percentages of men and women receiving fringe benefits were similar. Approximately 65% of women and men would be covered by a medical hospital plan, at least 78% of women and men would receive annual vacation leave, 68% of women and 70% of men would have employer-paid continuing education expenses, and 63% of women and 68% of men would have employer-provided liability insurance.

Graduate Characteristics

Responding graduates provided information on personal characteristics such as age, marital status, and number of children (Table 4). The mean age of females was 27.6 years, and the mean age of males was 27.4 years. Regarding marital status, 66% of female graduates were single, 30% were married, and 4% were divorced. Of the male graduates, 59% were single, 39% were married, and 2% were divorced. About 5% of the women and 13% of the men had one or more children. These characteristics are nearly identical to those reported for 1990 graduates.[2]

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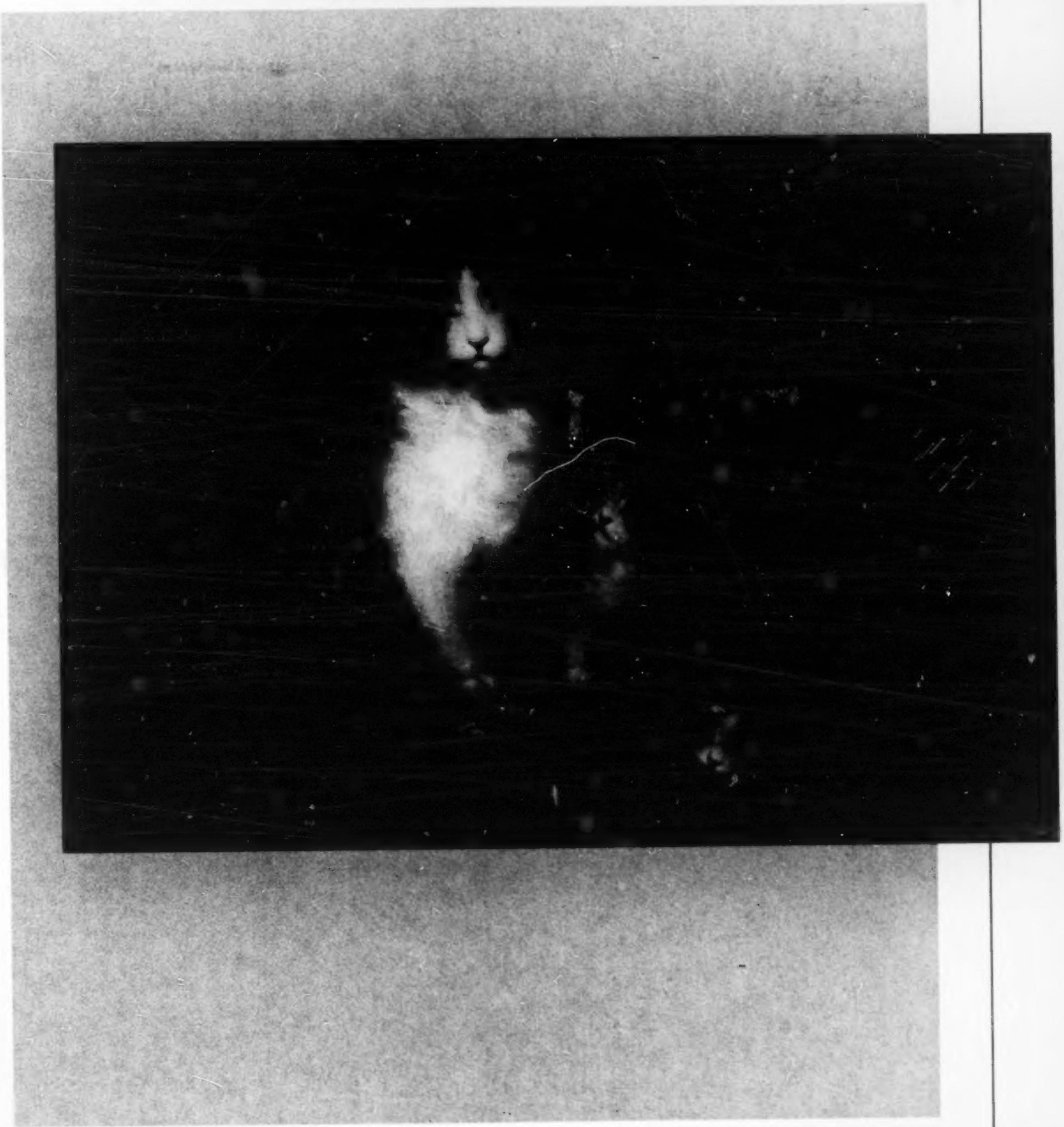

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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SUBSCRIPTIONS: For one year: members $50; others $100 in the United States and possessions; $120 in foreign countries. Single copies: $6.00 in the United States and possessions; $8.00 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

ADDRESS CHANGE: Send new address (and moving date) 45 days ahead. Include old address as it appeared on previous issues (if possible send label).

POSTMASTER: Send address changes to JAVMA, 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360.

Clinical clerkship curricula at United States and Canadian veterinary schools

Anthony Schwartz, DVM, PhD, and Elaine Bell, MA

Many of the veterinary schools in the United States and Canada are planning, and a few already have made, major changes in their curricula. In many cases, the movement toward change arose from institutional involvement in the Pew National Veterinary Education Program.[1] Curricular deliberations at these institutions have included a variety of questions, such as: Should partial or total clinical species tracking be initiated, that is, should education focus only or mainly on the species a student plans to serve in practice? Is there a need to expose all students to a prescribed core of knowledge, to assure qualification to enter any field of veterinary medicine upon graduation? Should problem-based learning be a major part of new curricula, replacing or augmenting lectures? Is there a need for fewer core and more elective/emphasis courses? Should there be more clinical education and less basic science didactics? Should hands-on clinical education begin earlier than in the current curriculum?

Asking similar questions, Tufts University School of Veterinary Medicine is considering changes in its curriculum. This report was developed because we wished to provide our Curriculum Committee with data pertaining to clinical clerkships (rotations—*see* Materials and Methods) at other veterinary schools. This led us to survey the other 30 institutions in the United States and Canada.

On the basis of internal needs, our initial interest mainly was on large animal clinical clerkships. As our study proceeded, however, many institutional respondents to the survey showed substantial interest in data concerning all clerkships. This led to a broadening of the goals of the study and an inclination to publish our findings for use by other educators dealing with similar questions at their institutions. We trust that this report will also be of interest to private practitioners and to students considering careers in veterinary medicine, as it shows the substantial diversity of veterinary curricula and the degree to which changes are afoot in contemporary clinical education.

Definitions

Clerkships are predominantly clinical rotations normally associated with fourth-year veterinary professional education, in which students have primary case management responsibilities under supervision of the clinical faculty. We extend the definition to include nonclinical practice rotations designed to provide exposure to other niches into which graduates might fit, for example, government, industry, and research.

Core clerkships are defined as those required of all veterinary students.

A *full tracking curriculum* is one in which there may be no core, or a core of only one or a few specific clerkship weeks, usually in one or more of the support disciplines (eg, radiology, anesthesiology, or pathology), associated with a requirement that students participate in one of a menu of species or other tracks, which prescribes the rest of the curriculum.

A *modified tracking curriculum* has a limited but more extensive and broad-based required core than does a full tracking curriculum. Modified tracking exposes students to clerkships dealing with multiple species and is associated with requisite participation in one of a menu of species or other tracks, which prescribes the rest of the curriculum.

Track-specific core clerkships are those required only of students participating in a formal track.

Electives are those clerkships in which students choose from a broad range of options, usually without any specific curricular goals.

In *selectives* (*restricted electives* at some institutions), students choose from a restricted list of options, usually with a specific curricular goal in mind.

Internal elective clerkships are available only within the institution.

Externships are external electives, that is, those that are available outside the institution, such as at

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From the Office of the Associate Dean, Clinical Education and the Department of Surgery, School of Veterinary Medicine, Tufts University, 200 Westboro Rd, North Grafton, MA 01536.

The authors thank the institutional representatives for their time and effort in providing information concerning their institutions' programs and plans.

private veterinary practices (we do not differentiate between more formally regulated externships, sometimes called preceptorships, and less regulated externships).

Required electives are those that are mandated for all students within the institution. In certain instances, these may be required between the third and fourth years of the curriculum.

Optional electives are those that the student may decide to use not for a clerkship, but for vacation or travel to a distant elective site (these may be taken during the school year and/or between the third and fourth years of the curriculum).

In the tables, for the sake of uniformity, in certain cases we have used a title that is different from that used at a specific institution, but which implies the same content stated by the institution. For example, pathology clerkships include anatomic pathology (necropsy and histology) and clinical laboratory (clinical pathology) exposure, but cannot readily be separated into the two discrete components. Specific institutional clerkship content may be stated by notation in the table legends.

The survey—Starting in late 1990, telephone dialogues were initiated with one or more institutional representatives, eventually including all United States and Canadian veterinary schools. Information was obtained about the number of weeks (one week of half-day exposure was considered one half week) of various clinical clerkships, as well as changes planned in the clerkship curriculum. First a summary of the information, and later a draft of the manuscript, was distributed to at least one institutional representative for comments and necessary changes.

Tabulated data include only weeks of clerkships required of every student at the listed institution, plus the minimum number of weeks of optional electives available to all students. If tracking or emphasis areas exist beyond a core, only the core is described in detail. All listed clerkships take place in the fourth year, unless otherwise stated. All data and programmatic changes provided are current as of August, 1991.

The data reflect only discrete periods formally restricted to the listed clerkship subject. At times, this involves two or more formal subrotations within a clerkship, both of which are listed in the tables. For example, the institutional curriculum may list only small animal surgery as the clerkship, but if each student is required to spend defined periods in soft tissue surgery and orthopedic surgery, the two subrotations are listed. In contrast, if, for

Table 1—Required large animal clerkships at United States and Canadian veterinary schools

	Clerkship (weeks)																
Institution	**LAC**	**LAS**	**LAM**	**LAEM**	**LAFS**	**EQC**	**EQS**	**EQM**	**EQFS**	**FAC**	**FAS**	**FAM**	**FAFS**	**HH**	**TH**	**Other**	**Total**
Auburn						4			1	5			2.5		2.5		15
California																	0*
Colorado		2		1				1	1			2		1			8
Cornell		4	2		4												10
Florida		4	4										2		2		12
Georgia			3		2†		2.5				2.5			2†	2†		14
Guelph		2	2											4	1		9
Illinois					3	3				3							9
Iowa					2		2	2		2					2		10
Kansas							3	3		6						1‡	13
Louisiana					2		3	2		2				1			10
Michigan							2	2		3			3				10
Minnesota		3	3		3										3		12
Mississippi	4					6§				6§							16
Missouri						8				4			4		4		20
Montreal					2		2	2		3				1	2		12
N Carolina						4				4				4			12
Ohio					3.33		1.67	1.67		3.33				3.33			13.33
Oklahoma						2				2							4
Oregon		4	3										4				11
Pennsylvania		4	4		2												10
Pr Ed Island																	0‖
Purdue																	0*
Saskatchewan		4	2		2												10
Tennessee		4	4		4									1		3¶	16
Texas					2		2	4		2				2	4		16
Tufts		4	4		4												12
Tuskegee	4				4												8
Va-Md	3				3												6
Washington		4	4											6		1#	15
Wisconsin		2	4		2										2		10

*Tracking curriculum, with all required large animal clerkships in relevant tracks only. †Students may select all three marked programs at two weeks each, or two of three programs at three weeks each. ‡Meat Animal Research Center. §Third-year rotation. ‖Totally elective, nontracking clerkship curriculum. ¶Divided among large animal anesthesia, neonatal intensive care, and ambulatory (LAFS). # *Selective:* Large animal medicine, large animal surgery, or large animal anesthesiology.

LAC = large animal clinics (surgery/medicine); LAS = large animal surgery; LAM = large animal medicine; LAEM = large animal emergency medicine; LAFS = large animal field service/ambulatory; EOC = equine clinics (surgery/medicine); EOS = equine surgery; EOM = equine medicine; EOFS = equine field service/ambulatory; FAC = food animal clinics (surgery/medicine); FAS = food animal surgery; FAM = food animal medicine; FAFS = food animal field service/ambulatory; HH = herd health/population medicine; TH = theriogenology.

Table 2—Required small animal clinical clerkships at United States and Canadian veterinary schools

	Clerkship (weeks)									
Institution	**SAC**	**SAS**	**ORT**	**GST**	**SAM**	**ICU**	**EM**	**OPR**	**Other**	**Total**
Auburn			2.5	2.5	3.3			2.5		10.8
California										0*
Colorado			2	2	2	1	1			8
Cornell			2	2	3			1		8
Florida			2	2	4					8
Georgia			3	3	4			3		13
Guelph		2			2	1				5
Illinois		3			3					6
Iowa			2	2	4	2				10
Kansas			3	3	4			2		12
Louisiana			2	2	5					9
Michigan			2	2	2	2		2		10
Minnesota		3			6					9
Mississippi	4	4†			4†	4†	2			18
Missouri			4	4	8					16
Montreal		2			2					4
N Carolina			2	2	4					8
Ohio			1.67	1.67	3.33	1.67	‡	1.67		10
Oklahoma		2			2	2		2		8
Oregon			1.5‡	1.5‡	2‡			1‡		6†
Pennsylvania			2	2	4	1	2			11
Pr Ed Island										0§
Purdue										0*
Saskatchewan		4			4					8
Tennessee			2	2	4					8
Texas		8‖			8¶					16
Tufts			2	2	4	4				12
Tuskegee		2.67			2.67			2.67		8
Va-Md		3			3					6
Washington			2	2	2		1	2	1#	10
Wisconsin		2			2					4

*Tracking curriculum, with all required small animal clerkships in relevant tracks only. †Third-year rotations. ‡Students in ophthalmology and radiology work double shifts, yielding a total of one week's nonscheduled exposure to emergency medicine service. §Totally elective, but nontracking clerkship curriculum. ‖All students take two weeks of general small animal surgery; they must also *select* three of the following rotations of 2 weeks each: orthopedic surgery, neurosurgery, soft tissue surgery, or ophthalmology. ¶*Selective;* students must complete four of the following five rotations of two weeks each: dermatology or neurology, cardiology/internal medicine, oncology/internal medicine, internal medicine, or community practice/exotic animals. #*Selective;* from a list of already completed small animal clerkships.

SAC = Small animal clinics (medicine/surgery); SAS = Small animal surgery; ORT = Orthopedic surgery; GST = General/soft tissue surgery; SAM = Small animal internal medicine or referral practice; ICU = Intensive care unit; EM = Emergency medicine; OPR = Outpatient/receiving or local practice.

example, anesthesia training is part of the surgery clerkship, but there is no defined period set aside for each student exclusively for anesthesia training, there is no subdivision of the clerkship in our tables.

Finally, we present information about existing new curricula as well as planned directions for change in clerkships at the various schools.

Results

Data are presented concerning the number of weeks of required large animal (Table 1), small animal (Table 2), and support, specialty, mixed species, and other (Table 3) clerkships. Table 4 shows required and optional elective clerkships, and Table 5 presents a summary of the data.

Full tracking curricula—The University of California and Purdue University have full tracking curricula.

California has eight available tracks: Mixed Animal Practice; Small Animal Practice; Large Animal Practice; Equine Practice; Food Animal Practice; Zoological Practice; Companion Animal Practice; and Small/Food Animal Practice.

A 36-week clerkship curriculum is available during the fourth year (including an optional elective week). All students in all tracks have three weeks of clerkships in common: a one-week clinical laboratory clerkship and a two-week anatomic pathology clerkship. In addition, all students have at least one week (up to two weeks in some tracks) of large and/or small animal anesthesia training (Table 3). All tracks require medicine and surgery clerkships, with the species dealt with varying with the track, and all but the food animal track require radiology. The track-specific core varies from 18 to 24 weeks.

The rest of the California curriculum consists of required selectives and electives. In three of the tracks, there are no required selectives, whereas two weeks of internal selectives are required in three tracks, and six weeks in two tracks. In the Food Animal and Small/Food Animal tracks, there also is a four- or two-week selective, respectively, consisting of an externship/preceptorship in which students select from a small list of practices. All students have three to 11 weeks of required internal elective clerkships, depending on the track (Tables 4 and 5). Finally, in addition to the one week of optional elective during the academic year, the 12 weeks between third and fourth years may be used for optional internal or external electives, without credit. During the latter period, access to internal optional electives is limited to those clerkships accepting students (Tables 4 and 5).

Purdue has eight available tracks: Mixed Ani-

Table 3—Required support, specialty, mixed species and other clinical clerkships at United States and Canadian veterinary schools and colleges

Institution	Clerkship (weeks)											
	RAD	ANE	PATH	CL	AP	CA	NE	OP	DR	MI	PH	Other	Total
Auburn	2.5	2.5		1.25	1.25		2.5	2.5	1.7				14.2
California		1*		1*	2*								4*
Colorado	2	2			1		1		1			1	8
Cornell	2	2		1	1			2	2				10
Florida	4	2		2	2	2	2	2	2			2	20
Georgia	3	4		1	1								9
Guelph	2	2	2				1					1	8
Illinois	3	3	3			0.75	0.75		0.75			0.75	12
Iowa	2	2		1	1		2			1	1	2	12
Kansas	3	3			1							1	8
Louisiana	5	1	5									2	13
Michigan	2	2		2	2								8
Minnesota	2	3		2	2			1	1	1	1		13
Mississippi	4†	4†	4†									2	14
Missouri	4	4		4	4			2					18
Montreal				3	2			.5	.5		1	1	8
N Carolina	2	2		2	2						4	8#	20
Ohio	2.33	1.67			1.67			1					6.67
Oklahoma	4	4		2	2							1	13
Oregon	1	2‡		1	1			1†		1			7
Pennsylvania	2	2			2	1.2	1.2	.8	2			1.8	13
Pr Ed Island													0§
Purdue				0.5*	1*					0.5*			2*
Saskatchewan	2	4		2	2								10
Tennessee	4	4		2	2		2	2	2			2	20
Texas	3	3		1	2					2	1		12
Tufts	3	3		1	2			1				4#	14
Tuskegee	4			4	4					4			16
Va-Md	3	3		1.5	1.5							3	12
Washington		4						1					5
Wisconsin	1	2			1	1	1	2	1			3#	12

*Tracking curriculum, with all clerkships in this category in relevant tracks only, except as specified in table and text. †Third year rotation. ‡Includes 1 week small animal clerkship in third year and 1 week large animal clerkship in fourth year. §Totally elective, nontracking curriculum; # *selective*.

RAD = Radiology; ANE = Anesthesiology; PATH = Pathology (combined clinical laboratory and anatomic pathology); CL = Clinical laboratory (clinical pathology); AP = Anatomic pathology (necropsy and histology); CA = Cardiology; NE = Neurology; OP = Ophthalmology; DR = Dermatology; MI = Microbiology; PH = Public health/regulatory medicine; Other = A variety of clerkships, as discussed in the text.

mal Practice; Companion Animal Practice; Small Animal Practice; Food Animal Practice (Ruminant Option); Food Animal Practice (Swine Option); Large Animal Practice; Equine Practice; and Nonpractice (eg, Research, Public Health, Regulatory).

The fourth-year curriculum consists of 10 five-week blocks. Of the 10 blocks, seven (five for the Nonpractice track) are required and three (five for the Nonpractice track) are elective (Tables 4 and 5). Included within the required blocks is a 10-week combined two-block program, which includes: a six-week period of required externship (Table 4); the only specific discipline courses common to all tracks, that is, one week of anatomic pathology, and one half week each of clinical laboratory and clinical microbiology (Table 3); and two weeks of optional electives (Tables 4 and 5). All tracks require medicine and surgery clerkships, with the species dealt with varying with the track.

Modified tracking curriculum—At Virginia-Maryland, a basic core of 24 weeks of specific discipline clerkships is required of every student (Tables 1-3). Beyond that, students must track in/emphasize one of five areas: Equine; Food Animal; Small Animal; Mixed Animal; or Government and Corporate (the latter comprises subspecialties, including: Research/Postgraduate; Regulatory/Inspection/Epidemiology; Aquatic/Marine Animal; Zoo/Wildlife; Laboratory Animal/Pathology/Toxicology; and Avian). There are 12 to 15 weeks of track-specific core, varying with the track, exclusive of required elective and externship weeks. The number of weeks of required electives varies from 9 to 12, including 0 to 3 weeks of externship and 6 to 12 weeks of unspecified ("Any" in the tables) electives, depending on the track (Tables 4 and 5).

Fully elective curriculum—The University of Prince Edward Island (PEI) has no core clerkship requirements—only 30 weeks of electives. The content of the elective period is totally up to the student, as long as at least 27 weeks of internal clerkships are chosen (Table 4). Tracking or emphasis is not specified, but is allowed.

Prefourth-year clerkships—Many schools offer minor clinical exposure, without primary patient care responsibilities, to students during their third and sometimes their second or first years. With the few exceptions to be described, formal clinical clerkships, with primary patient care responsibilities, are available only during the fourth year of education. Optional externships are available during the summer between the third and fourth years in many of the more traditional curricula (Tables 4 and 5).

Table 4—Required internal and externship elective clerkships and optional elective clerkships at United States and Canadian veterinary schools

Institution	Required Weeks				Optional (Weeks)
	Ext	Int	Any	Total	
Auburn	10	7.5	2.5	20	0
California			3*	3*	13
Colorado		12		12	12
Cornell			4	4	4
Florida			10	10	0
Georgia	4			4	8
Guelph	8	8		16	8
Illinois			12	12	12
Iowa			7	7	20
Kansas			15†	15	0
Louisiana		8		8	10
Michigan			14	14	8
Minnesota	4		10	14	4
Mississippi			36	36	6
Missouri				0	32
Montreal	3	3		6	12
N Carolina		4	4	8	8
Ohio			4-9‡	4-9‡	9-4‡
Oklahoma	2§		16§	22§	2
Oregon	8		8	16	8
Pennsylvania				0	16
Pr Ed Island		27	3	30	0
Purdue	6		15	21	2
Saskatchewan			4	4	0
Tennessee		2		2	4
Texas			4	4	0
Tufts			11	11	3
Tuskegee				0	12
Va-Md			6	9	3
Washington			12	12	10
Wisconsin			21	21	5

*Tracking curriculum; varies with the track (see the text); there are three to 11 weeks of "Any" electives required, varying with the track; this does not include selectives. †Six weeks must be spent in externship or advanced internal clerkship; 9 weeks may be any elective. ‡13 weeks are available for required and optional electives; five credit hours are required, which may take four to nine weeks to complete, depending on the clerkships selected, leaving nine to four optional weeks. §One externship lasting two, four, or six weeks is required, the length of which determines whether the number of weeks of "Any" electives is 20, 18, or 16, respectively, for a total of 22 weeks of required electives.

Ext = Externship/preceptorship; Int = Internal clerkship; Any = Any type of elective; Optional = Time available for vacation or electives, at student's choice, often including the summer between the third and fourth years, when available.

Table 5—Summary of clinical clerkships at United States and Canadian veterinary schools

Institution	Required Weeks					Optional elective weeks	Grand total weeks
	Large animal	Small animal	Support, specialty, mixed species, and other	Elective	Total		
Auburn	15	10.8	14.2	20	60	0	60
California	*	*	4*	3	35	13	48
Colorado	8	8	8	12	36	12	48
Cornell	10	8	10	4	32	4	36
Florida	12	8	20	10	50	0	50
Georgia	14	13	9	4	40	8	48
Guelph	9	5	8	16	38	8	46
Illinois	9	6	12	12	39	12	51
Iowa	10	10	12	7	39	20	59
Kansas	13	12	8	15	48	0	48
Louisiana	10	9	13	8	40	10	50
Michigan	10	10	8	14	42	8	50
Minnesota	12	9	13	14	48	4	52
Mississippi	16	18	14	36	84	6	90
Missouri	20	16	18	0	54	32	86
Montreal	12	4	8	6	30	12	42
North Carolina	12	8	20	8	48	8	56
Ohio	13.33	10	6.67	4-9†	34-39	9-4†	43
Oklahoma	4	8	13	22	47	2	49
Oregon	11	6	7	16	40	8	48
Pennsylvania	10	11	13	0	34	16	50
Pr Ed Island	0‡	0‡	0‡	30	30	0	30
Purdue	0*	0*	2*	21*	48	2	50
Saskatchewan	10	8	10	4	32	0	32
Tennessee	16	8	20	2	46	4	50
Texas	16	16	12	4	48	0	48
Tufts	12	12	14	11	49	3	52
Tuskegee	8	8	16	0	32	12	44
Va-Md	6	6	12	9	48	3	51
Washington	15	10	5	12	42	10	52
Wisconsin	10	4	12	21	47	5	52

*Tracking curriculum, varies with the track. †Thirteen weeks are available for electives; five credit hours are required, which may take four to nine weeks to complete, depending on the clerkships selected. ‡Totally elective, nontracking clerkship curriculum

Exceptions to exclusively fourth-year core primary care clerkships include the following:

Tuskegee University divides each clerkship experience equally between third and fourth years, with the students having one half day of didactics and one half day of clinics each day (*see* Half-day vs full-day clerkships).

The University of Missouri completes didactic exposure after the second year, and then requires seven clerkship blocks of eight weeks each (Tables 1-3), including a two-week vacation period and four blocks of eight weeks each of free time (ie, electives; Table 4) during the subsequent 22 months. Required or elective blocks are randomly assigned throughout the final two years.

Mississippi State University also completes all preclinical didactic exposure by the end of the second year. Students then have 36 weeks of required clerkships during the third year, and 12 weeks during the fourth year (Tables 1-3). In addition, during the fourth year, there are 36 weeks of electives, including up to 12 weeks of externship and the option to repeat any of the core clerkships (Table 4).

Oregon State University does not have a small animal hospital; required small animal clerkships are fulfilled at Washington State University during the Oregon State students' third year (Table 2), including small animal anesthesia (Table 3).

The University of Pennsylvania provides the opportunity for 5 to 10% of third-year students to participate in 8 weeks of clerkships, instead of third- or fourth-quarter elective didactic course work. This is in addition to, not instead of, fourth-year clerkships.

Half-day vs full-day clerkships—All of the clerkships listed for Tuskegee University are fulfilled during one half of each day of the week, plus weekend coverage. Represented in Tables 1-3 is estimated contact time in the clerkships, derived by dividing the number of half-time weeks by two.

Large animal clerkships (Table 1)—All but three schools (California, Purdue, PEI) require large animal clerkships, with the total required weeks varying from four to 20. At 21 of the institutions requiring large animal clerkships, one to four weeks of field service (ambulatory—exclusively or mainly individual animal problem management) are required (plus Georgia, which offers it as one of a selective). Field service clerkships are listed as large animal at 15 schools (plus Georgia's selective). They are separated by species into food animal and equine only at Auburn; there is a solely equine field service clerkship only at Colorado State, and a solely food animal clerkship at four schools (Florida, Michigan State, Missouri, Oregon State). A clerkship in herd health is required at 9 institutions, and it is one of a selective at Georgia.

The breakdown of in-hospital large animal rotations varies as follows: at 13 schools the clerkships are only general, that is, large animal; at 12, clerkships are separated by species (equine and food animal); and three have general large animal and species-restricted in-hospital clerkships. Theriogenology is a required clerkship at nine institutions (in most instances, this includes small animal exposure) and is one of a selective at Georgia.

Small animal clerkships (Table 2)—Of 31 institutions, 28 (all but California, Purdue, and PEI) have required small animal clerkships. The number of required weeks varies from four to 18. Small animal surgery is not subdivided at 11 of the 28 institutions, whereas it is subdivided into orthopedics and soft tissue surgery at 17. Separate small animal intensive care unit clerkships are required at eight institutions. Emergency medicine clerkships exist at four (plus a nontabulated double shift, which provides for one week of emergency medicine, at Ohio State, and a combined clerkship with outpatient/receiving at Michigan State and Oklahoma State). Outpatient/receiving (variably known as local practice) is a clerkship at 10 institutions, always in conjunction with another clerkship termed internal medicine (or referral practice).

Support, specialty, mixed species, and other clerkships (Table 3)—Only PEI does not require clerkships in this category. Radiology clerkships are required of all students at all institutions except California, PEI, Purdue, Montreal, and Washington State. Specific anesthesia clerkships are required at all except Montreal, PEI, Purdue, and Tuskegee. Twenty-nine of the 31 institutions require anatomic pathology as a separate clerkship or defined subrotation (25 institutions), or as a component of the pathology clerkship (anatomic pathology plus clinical laboratory, four institutions). Separate clinical laboratory clerkships are required at 20 institutions. At two institutions (Washington State, PEI) no clerkship is required in pathology, clinical laboratory, or anatomic pathology. One or more of the specialty clerkships, cardiology, neurology, ophthalmology, and dermatology, is required at 17 institutions. Generally, these are mixed species in nature, although they deal mainly with small animal patients. Microbiology and public health exist as discrete clinical experiences at five institutions each. A variety of types of clerkships are listed under "Other" in Table 3. These include selectives (four institutions), various other laboratory experiences (three institutions), oncology (two institutions), zoo and wildlife (two institutions), and respiratory medicine, pharmacy, and pediatrics/genetics (one institution each).

Electives (Table 4)—All but three (Missouri, Pennsylvania, Tuskegee) of the 31 institutions require students to be involved in elective clerkships, varying in duration from two to 36 weeks. For the 28 schools requiring electives, externships only are required at five, internal clerkships are required at five, and both types are required at three, whereas 15 institutions do not specify the type of elective (ie, "any"). In addition to required electives, optional electives are allowed at 22 of the institutions. They also are allowed at the three institutions not requiring electives. The duration of optional electives varies from two to 32 weeks at the 25 institutions offering them.

Summary of clerkships (Table 5)—The duration of required clinical clerkship exposure varies from 30 (Montreal, PEI) to 84 weeks (Mississippi State). Adding the period available for optional clerkships brings the total length of time available for clerkships to 30 to 90 weeks, the longest being at the two institutions with full-day third- and fourth-year clerkships (Mississippi State, 90; Missouri, 86).

Institutional interactions—Some veterinary schools are interacting on a formal basis in the provision of education to students. For example, Oregon State, which has no small animal hospital, relies on Washington State to provide all required small animal clerkships. The concept of multi-institutional consortia is growing also; these formally expose students to areas of special emphasis/expertise not available at their home institution. One example is the Food Animal Consortium, which is expected to involve 41 students during its second year in 1991/1992. The establishment of the consortium was assisted by planning money provided by the Pew National Veterinary Education Program. It involves the following institutions and areas of special capability: California, large dairy herds kept in confinement, and small ruminants; Florida, dairy and beef cattle kept on pasture throughout the year; Illinois, swine; Kansas State/Nebraska, beef cattle; and Michigan State, small dairy herd operations.

Recently revised clerkship curricula—Three institutions have instituted new clerkship curricula, as represented in the tables, as follows: Auburn and Virginia-Maryland during the 1991/1992 academic year, and California, during 1990/1991. All other current clerkship curricula have been in existence since prior to the 1990/1991 academic year.

Institutions planning changes in their clerkship curriculum

Eighteen schools are planning or considering changes, as follows:

Colorado State University—Colorado State is in the midst of a change of curriculum, which started with the first-year class in 1990. There are definite plans for developing a fourth-year tracking curriculum, to go into effect in May 1993. The current plan is to allow four tracks: Equine, Small Animal, Food Animal, and Nontraditional Medicine. There would be a decrease in the core clerkships required of all students, to six weeks, including two weeks each of anesthesia, radiology, and anatomic pathology. In addition, there would be 20 or 21 weeks of track-specific core clerkships, and 9 or 10 weeks of electives (depending on the track), for a total of 36 weeks of core requirements during the fourth year. This would be exclusive of optional electives during the summer between the third and fourth years.

Cornell University—A move to a 12-month fourth-year curriculum is planned, with a target date for implementation of May 1992. There would be 32 core clerkship weeks (representing an increase from the current curriculum of one week of large animal medicine, one week of anesthesia, one week of small animal internal medicine, and one week of small animal outpatient/receiving), four weeks of externship or internal courses from a selective, and 16 weeks comprising optional electives, which can be fulfilled internal or external to the institution. Cornell is not considering tracking.

University of Florida—There is an ongoing review of the curriculum, including a move toward modified tracking, with a final plan expected by the end of 1991. It is expected that clinical exposure will be expanded into the third year. The target for implementation is the 1992/1993 academic year.

University of Guelph—A new clerkship curriculum has been approved to go into effect in September 1992. It will involve 16 weeks of core discipline clerkships and 14 weeks of electives in the fourth year, and eight weeks of required externships between the third and fourth years. Specific tracks will not be required.

Iowa State University—Curriculum review is ongoing, with a move toward tracking being planned. The faculty has approved a 14-week core requirement for all students, which will include anesthesia, radiology, anatomic pathology, clinical microbiology, intensive care, and emergency medicine clerkships. A further, required tracking component will include at least one species-oriented block, from among Small Animal (12 weeks), Food Animal (8 weeks), or Equine (4 weeks) options. In addition, up to 10 weeks of electives will be available. The change will begin in the summer of 1992. Further, the faculty is considering curricular revisions in which required didactic course time would be cut by as much as 50%. It is anticipated that clinical exposure would be expanded to the first through the third years. Eventually, there is consideration that the third year may look like the current fourth year, whereas the fourth year would involve more advanced studies, to become more like an internship.

Louisiana State University—A review of the curriculum is ongoing, with the likely result to be an increase in electives and a decrease in core. This is estimated to require at least two years to implement, and is likely to involve didactic and clinical clerkship courses.

University of Minnesota—A new curriculum is being developed, with a target for implementation of fall, 1993. As of now, it is conceived that five tracks will be offered, including Small Animal, Mixed Animal, Equine, Food/Production Animal, and Research/Public Practice. In addition, there is consideration of decreasing didactic course work to allow more independent learning, and of expanding clinical exposure into the third year of the curriculum.

University of Missouri—The only planned change is as follows: At present, some of the clinical clerkships include about two hours of didactics per day. In 1993, all such didactic time will be removed from the clerkships and combined to form a separate required didactic block.

University of Montreal—A major curriculum review is ongoing. This likely will be associated with a decrease in core didactics and an increase in clinical exposure. It is presumed that eventually there will be core didactic courses and clerkships, and clinical tracking with core-specific track courses and electives. Fall 1993 is the target for implementation.

The Ohio State University—There is consideration of decreasing core species courses, converting to a semester from a quarter system, increasing free (elective) time, and beginning clinical clerkships in the spring semester of the third year. The latter would allow electives during the last semester of the fourth year. If approved by the faculty, the tentative plan is to phase in the revised curriculum, with the first changes affecting the first-year class during the fall of 1993.

University of Pennsylvania—A draft of an Academic Majors (ie, modified tracking) curriculum is under faculty consideration. Five majors have been identified: Companion Animal; Equine; Food Animal; Biomedical Research; and Specialized (eg, zoo and wildlife, laboratory animal, aquatic animal). There would be a 10 to 20% decrease in required core didactic course work. Further, there would be more elective didactic courses, earlier clinical exposure, and greater flexibility in selecting clerkship experiences.

University of Saskatchewan—A committee is considering a plan to decrease the core and increase the number of electives, with "enrichment opportunities." There is a plan to implement these changes in the 1992/1993 academic year.

University of Tennessee—There is discussion of moving some clinical exposure of students to the early years of the curriculum, and increasing elective clerkship time in the fourth year. There are also preliminary plans to increase the exposure to problem-oriented/problem-solving courses throughout the curriculum.

Texas A&M University—A new fourth-year curriculum has been developed, with a start date of May 1992. Core rotations will include eight weeks each of small animal clinics and large animal clinics, four weeks of laboratory services, and two weeks each of anesthesiology and radiology. An eight-week reduction in core clinical clerkships would increase the elective period by an equal amount.

Tufts University—-A formal curriculum review is ongoing, with no target date for implementing changes. Although specifics are not finalized, a central component likely will be a substantial decrease in the didactic core, with increased availability of time for earlier clinical exposure or involvement in research. Changes in the clerkship curriculum, including bringing clerkships into the third year, are under consideration.

Tuskegee University—A formal curriculum revision is under consideration, with a target date for implementation of fall, 1992. A modified tracking system is proposed, with the fourth year divided into 10 equal blocks over a 12-month period. Seven of the 10 blocks would constitute the core, leaving three blocks dedicated to electives for tracking/emphasis. There would be full-day exposure in the fourth year only, instead of the present half-day exposure during the third and fourth years. There would, however, continue to be one half day per week of exposure to clinics in the third year, as an introduction. The overall content of the core would not change substantially.

Washington State University—A revision of the curriculum is under consideration to decrease the core and increase elective options in didactic and clerkship courses. The target date for implementing the changes is June 1992.

University of Wisconsin—There is some consideration to set aside time in the first three years for clinical exposure and problem solving, in exchange for didactics.

Discussion

For the purposes of this report, we have restricted our attention to clinical clerkships. It deals with undergraduate professional veterinary clinical education in an era of major national movement toward change in all aspects of the professional curriculum. In some cases, the changes have been said to be associated, in part, with involvement in the Pew National Veterinary Education Program[1] (although several institutions indicated that they had been considering changes prior to or outside of the Pew process).

We have observed several trends for modification of clerkship curricula:

First, there is movement toward decreasing core requirements and increasing electives, much in accord with trends in revising didactic, preclinical veterinary curricula.

Second, there seems to be movement toward species tracking. Two institutions (Purdue, California) have formalized full tracking clerkship curricula (a maximum of a few weeks of core support clerkships required of every student—the rest, a mix of track-specific core and selective and elective exposure, varying with the track). Others noted previously are in the process of considering a similar curriculum. Modified tracking is a less restrictive approach to allowing species or other discipline concentration/emphasis in the curriculum. Virginia-Maryland was the first example of such a curriculum, and now some other institutions are considering this approach. This type of curriculum allows students to obtain a base of hands-on knowledge of all domestic species, but to emphasize/enrich exposure to the species or nonpractice track of interest to them at that stage of their education. In PEI's novel, totally elective, clerkship curriculum, there are no formal tracks, but the students are at liberty to arrange their schedules to become functional tracks.

Third, there is a tendency toward extending the period during which clerkships are being offered, for example, by expanding such exposure into the third year of the curriculum, or to a 12-month from a 9-month curriculum. This often is associated with plans to decrease the core didactic curriculum and to allow the option to pursue emphasis in didactic courses and clerkships. Simultaneous with the latter, there is consideration of moving some didactic course work into the current clerkship year(s). Both approaches bring with them a hope that the juxtaposition of related clinical and didactic exposure might render both components more meaningful to the student. That is, by better demonstrating their clinical relevance, basic/didactic principles and facts might be more readily assimilated and retained. On the other hand, Tuskegee, which has full integration of didactics and clinical exposure during the third and fourth years, is considering a more classic separation of clinical and didactic education.

Fourth, several schools are offering emphasis/tracking in nonpractice career development during what otherwise would be the clinical clerkship year. This is associated with expanding niches for veterinarians in biomedical research, governmental, and industrial positions.

We will now comment on the trend toward

tracking clerkship curricula. First let us consider the full tracking curriculum, which allows students the ability to choose their clinical clerkship curriculum from a number of species-related or nonpractice choices. Although most students may opt for general, multispecies exposure, full tracking allows students to choose never to have hands-on clinical exposure to more than one or a few species.

Many arguments against the full tracking clerkship curriculum have been based on the fact that those who choose a species track restrict their hands-on clinical knowledge base:

- Full tracking, for those students who take a restrictive option, greatly diminishes one of the fundamental strengths of a general undergraduate veterinary education, that is, the production of comparative clinician/scientists. This sets us apart from our medical colleagues when we choose to perform research, especially in regard to knowledge of and experience with various animal species that may serve as models of human disease. First-hand knowledge of the similarities and differences between species makes us better clinicians and biomedical scientists than would otherwise be the case.
- Limited licensure is a potential eventual result of full tracking.
- Restricted hands-on animal experience with one or a limited class of species renders changes in professional employment directions more difficult, because of a lack of knowledge (possibly requiring additional formal training) and the potential need to be subjected to a new licensing examination. The limited degree of exposure to multiple species during a traditional veterinary curriculum provides the student with more first-hand clinical knowledge with which to decide on career options, and this background provides greater self-assurance, to render more feasible a decision to change veterinary disciplines even late after graduation.
- Students may not have enough information to critically select a restricted curriculum at their stage of education, with potentially negative effects if they decide to change their direction even shortly after graduation.

Those in favor of tracking[a] counter that:

- All students receive didactic education in all species during the preclinical years of a tracking curriculum, so they are provided with the knowledge base needed if an eventual change in career within the profession is desired.
- Students in all tracks are exposed to the fundamentals of surgery and medicine during exposure to their species of interest. This is adequate as a base for entry-level skills, to allow easy shifting of clinical species specialization after graduation.
- In the future, additional clinical training essentially will be required of individuals seeking to change their species specialty, regardless of their species exposure during their professional education. This will be dictated by increasingly sophisticated clients and the litigious nature of United States society. Further, exposure of students to several weeks of hands-on clinical training during their professional education does not provide any long-lasting clinical skills in a given species unless graduates continue to use that knowledge.
- A student may be assisted in making an informed choice about tracking, by providing appropriate course work prior to the decision. At Purdue, for example, this includes a course on "Careers in Veterinary Medicine" in the preveterinary curriculum, orientation sessions on veterinary careers and clinical tracking in years 2 and 3 of the veterinary curriculum, and assignment of faculty advisors to third- and fourth-year veterinary students, to assist them in their decision and its implementation.
- Tracking can facilitate expanding the spectrum of career options available to graduating veterinarians, by allowing students to be trained for access to emerging professional niches, for example, government, industrial and biomedical research options (in the Nonpractice track).

Even given these responses, we remain to be convinced about the propriety of full tracking curricula. It is our opinion that some form of modified tracking (core plus emphasis components) makes more educational sense. This approach is analogous to the time-honored undergraduate majoring in history, biology, and similar subjects. Thereby, all students have a basic curriculum, enriched via the subject matter of the major. It is noteworthy that the University of Pennsylvania is planning to use this terminology, rather than tracking or emphasis, as it alters its curriculum. Modified tracking/majoring would appear to fulfill the societal need to have better trained entry-level clinicians in their chosen species or other specialty at the time of graduation, than is possible with a completely general, multiple-species curriculum. Further, modified tracking would not have the previously mentioned possible negative attributes of the full tracking curriculum.

An alternative to the Virginia-Maryland modified tracking curriculum is to have a restricted core and allow a substantial amount of elective time. In this model, students can select those clerkships they wish to emphasize, without a formal tracking structure, but with adequate faculty advice to allow an informed selection of the emphasis courses. This would be, essentially, a blend of the PEI and Virginia-Maryland curricula. As may be observed from the summary of plans presented previously, many of the veterinary schools appear to be selecting this approach, in preference to formal tracking.

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[a] J. F. Van Vleet, Purdue University, West Lafayette, Ind, and G. H. Cardinet, University of California, Davis, Calif: Personal communication, 1991.

The further development of formal interinstitutional educational programs is to be commended, including regional or national veterinary educational consortia, similar to the Food Animal Consortium described already. This educational approach allows access by students to programs not available or inadequate for their purposes at their home institution.

For consortia to succeed, institutions may have to modify how they compete for students. That is, whereas now they may emphasize their relative academic or programmatic strengths, compared with other schools, this may not be as possible in a consortium arrangement. This could be a difficult problem in these days of more student slots and fewer applicants.

Through consortia, veterinary educational institutions could take advantage of unusual, expensive, and sometimes unique areas of faculty expertise, caseload characteristics, and equipment and facilities at other institutions. This would allow institutions to more readily accept that they do not have to be all things to all students. Consortia could increase the quality and efficiency of education and decrease the cost, a service to our students.

There appear to be as many experiments in professional veterinary education as there are educational institutions. The interesting thing is that all the approaches seem to work, as judged by the quality of our graduates. Perhaps it is the quality and enthusiasm of the student that is a greater determinant of the outcome of education than the attributes of a specific curriculum. This may be particularly true because of the generally high quality of United States and Canadian schools. The near future should be an interesting period in veterinary education. We might well see some of the noted trends develop into more defined national or international directions in curriculum reform.

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1. Pritchard WR, ed. *Future directions for veterinary medicine.* Durham, NC: Pew National Veterinary Education Program, 1989.

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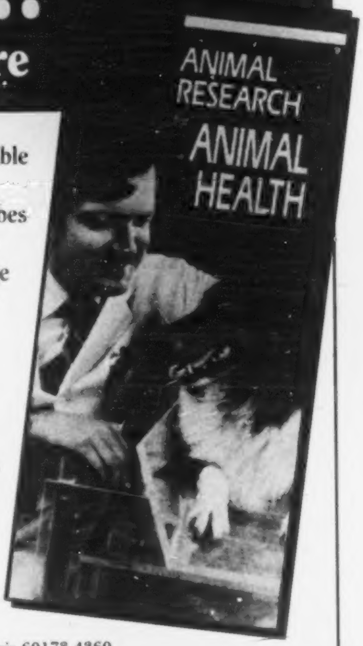

Animal Research for Animal Health is a new brochure now available to AVMA members for public distribution. Produced in 1989 by the Foundation for Biomedical Research, the eight-panel brochure describes the many advances in veterinary medicine made possible through the use of laboratory animals. Although most people have some knowledge of the human health benefits derived from animal research, many are unaware of the equally significant contributions that animal research has made to animal health and welfare.

The brochure features many examples of such contributions, including new vaccines, diagnostic techniques, surgical procedures, and therapeutics. Multiple copies are available free of charge to AVMA members upon request, and are suitable for distribution to clients and others interested in the facts about animal research.
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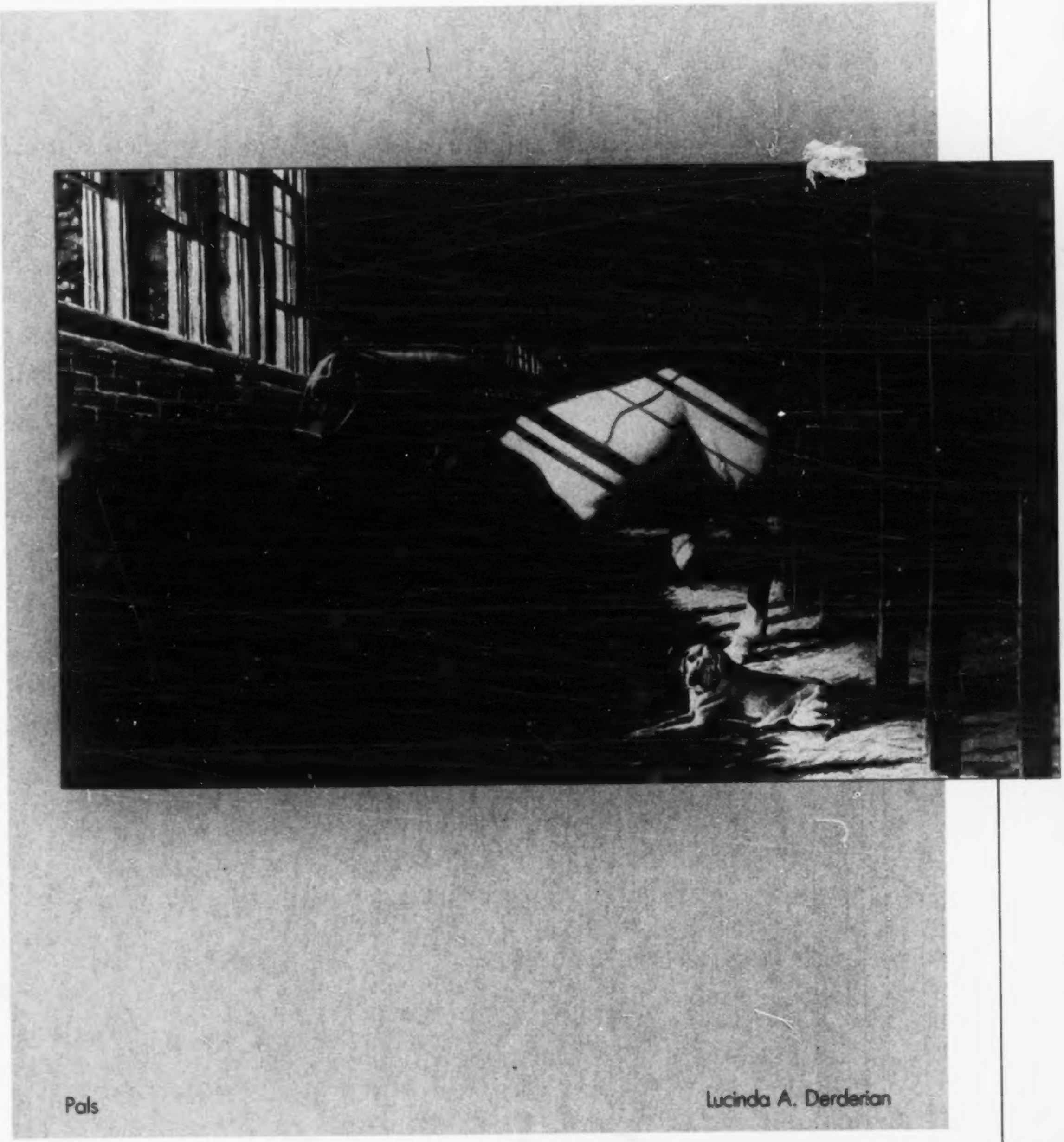
February 15, 1992, Volume 200, Number 4

JOURNAL

OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION



Pals

Lucinda A. Derderian

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 200 February 15, 1992 No. 4
JAVMA 200 (4) 409-576 (1992)
ISSN 0003-1488

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Lucinda Derderian, a veterinary technician at North Shore Animal Hospital in Lynn, Massachusetts, is a part-time artist specializing in portraits of horses.

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SUBSCRIPTIONS: For one year: members $50; others $100 in the United States and possessions, $120 in foreign countries. Single copies: $6.00 in the United States and possessions, $8.00 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

ADDRESS CHANGE: Send new address (and moving date) 45 days ahead. Include old address as it appeared on previous issues (if possible send label).

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BPA

Activities Divisions. Computer and telephone equipment is centralized in one room on the fourth floor.

Multicolored carpet with blue and mauve is used throughout the space, and it is accented with solid blue and mauve inlays. Walls and panels for system furniture are predominantly light blue. The woodwork is cherry-stained mahogany.

Several businesses have leased the available suites on the first floor. The entire second floor is leased to a health maintenance organization. The third floor includes numerous private offices and support spaces. Office space is being kept available on the third floor for occupancy by other veterinary medical groups. Several groups have already expressed interest in some of the space.

The move to the new AVMA building signifies more than a mere move to more space. It provides an opportunity for the AVMA to provide enhanced member services and to increase support to and interaction with other related groups. The AVMA Officers, Executive Board, staff, and members who have visited have all been proud of the facility representing our Association and our profession. An open invitation is extended to visit us whenever you have the opportunity.

Membership

AVMA's membership increased by 3% to 52,183 members at the end of 1991. The 2,623 new members include 2,021 new graduates. Of the 2,025 graduates of US veterinary colleges during 1991, 1,996 (98.5%) joined the AVMA. All of the graduates from 14 veterinary colleges joined the Association. The Association lost 1,097 members during the year due to death (187), resignation (81), and nonpayment of dues (829). As shown in the table below left, 76.1% of the US members are in private practice; 7.5% are active in academic disciplines and clinical specialties; 8.1% are involved in public health, regulatory, military, and other activities; 5.7% are retired; and 2.6% (mostly new graduates) are in unknown activities.

AVMA Membership According to Professional Activity—Dec 31, 1991

Bovine practice (exclusive)	481
Equine practice (exclusive)	1,921
Porcine practice (exclusive)	75
Large animal practice (all species)	1,518
Mixed practice (predominantly large animal)	4,430
Mixed practice (50-50 large and small)	3,382
Mixed practice (predominantly small animal)	5,408
Small animal practice (exclusive)	22,201
Poultry practice (exclusive)	144
Feline practice (exclusive)	144
Anatomy	89
Biochemistry	11
Microbiology	271
Parasitology	68
Pathology	901
Pharmacology	87
Physiology	107
Radiology	136
Toxicology	155
Surgery	446
Pathology, Avian	75
Pathology, Clinical	146
Ophthalmology	135
Nutrition	71
Clinician	300
Theriogenology	145
Anesthesiology	95
Internal Medicine	245
Cardiology	38
Dermatology	73
Neurology	25
Epidemiology	95
Oncology	34
Aquatic	45
Avian Medicine	126
Ethology	6
Veterinary public health	224
Veterinary preventive medicine	67
Teaching and research	501
Regulatory veterinary medicine	682
Administrative	179
Laboratory animal medicine	714
Wildlife, zoo and fur-bearing animals	261
Extension	57
Diagnostic veterinary medicine	160
Industrial veterinary medicine	430
Military veterinary service	407
Veterinary technician educator	55
Other veterinary medicine	466
Retired	2,970
Unknown professional activity	1,381
Total membership	52,183

JOURNAL SUBSCRIPTIONS

Although the majority of subscriptions to the AVMA journals go to members, nonmember subscriptions provided $320,000 income to the AVMA in 1991. Members received more than 48,800 subscriptions to the *JAVMA* and 5,800 subscriptions to the *American Journal of Veterinary Research*. Nearly 2,800 members elected to receive both journals. More than 2,600 nonmembers subscriptions to the *JAVMA* yielded $175,000, and 1,465 nonmember subscriptions to the *AJVR* yielded $145,000. The income from nonmember subscriptions helps to defray the cost of producing the journals while furthering the AVMA objective to disseminate veterinary knowledge. The nonmember subscriptions are primarily to institutions, libraries, and commercial companies, with more than 50% of the subscribers located in other countries.

DUES INCREASE

In July 1991, the House of Delegates approved a Bylaws amendment to increase AVMA member dues to $175 per year for active members and $150 for associate and affiliate members. The increase resulted from the increased cost to accomplish all of the functions and to carry out all the activities described in these pages. As those costs increased, non-dues revenue decreased because of sharply lower interest rates that reduced investment income.

Although the dues increase becomes effective during a recessionary period in the nation's economy, the activity it supports is essential to the advancement of the veterinary profession at a critical time. Most significant among the problems being addressed are costly legislative initiatives that are essential to try to secure authority in the law for veterinarians to be able to practice effectively, using human-labeled pharmaceuticals and extra-label use of veterinary pharmaceuticals when efficacious label-authorized veterinary products are not available. In addition, a food safety workshop is intended to combat misperceptions in the minds of the public, consumer groups, and congressional staff members that are creating pressure on Congress and the Food and Drug Administration to limit the pharmaceuticals available to veterinarians.

AVMA DIRECTORY

The annual *AVMA Directory* is well received and much used by the members. A recent survey reported that 65% of the members regularly refer to the Directory.

The 1992 *AVMA Directory* was prepared, printed, and mailed in December to all AVMA members. The six-month effort involved collecting current information from all organizations, schools, government agencies, and specialty groups and updating the reference section in which they are listed. The AVMA film and videotape catalog was updated as was information in the *Digest of Practice Acts* and the *Catalog of materials* available from the AVMA. Alphabetic and geographic membership listings were edited three times, and advertisements were sold and included in the publication.

We appreciate the cooperation of all individuals and organizations that provided updated data in a timely manner to enable us to meet the production deadlines. We also appreciate the support of advertisers and other purchasers. The income derived from those sources has enabled us to keep the net production cost to less than $2.50 per member from dues income.

MEMBERSHIP BENEFITS AND SERVICES

In addition to the very important intangible benefits of governmental affairs representation, public information, educational quality assurance, and scientific publications that are described throughout this summary report, the AVMA continues to try to negotiate favorable group rates for services based on the collective buying power of the total membership. In addition to AVMA's highly beneficial insurance programs, AVMA members now benefit from a number of services at rates that are significantly less than rates available to the general public.

American Bankcard Service—The American Bankcard Service offers to process members' Mastercard and Visa charges at the low rate of 1.7% plus 20 cents per transaction. The rate will be adjusted only to accommodate changes in the rates charged to the American Bankcard Service by Mastercard and Visa. Members who are not yet using the service should call 1-800-933-0983 to enroll or to secure further information.

Relocation Services—Mayflower Van Lines and North American Van Lines offer relocating AVMA members substantial discounts from interstate tariff rates for their moves. Although local market competition may produce even greater savings, and it pays to secure competitive bids, members are assured discounts of 36 to 40% by Mayflower and North American. For Mayflower service, call Janice Elges at Glen Ellyn Mayflower 1-800-323-1302 (In Illinois, call 708-543-0500). For North American Van Lines call John Simon at George Noffs Moving and Storage 1-800-323-7790 (In Illinois, call 708-870-5554).

Automobile Rentals—Alamo Rent-a-Car and Budget Rent-a-Car companies offer AVMA members their corporate rates for automobile and truck rentals. More than 250 member rentals were reported by the two companies, which also pay a 5% royalty to the AVMA on each rental. Thus, members who use the programs save directly on their rental expenses, and indirectly by increasing income to the association that helps defray its cost of operation.

Long-distance Telephone Discounts—In July 1990, AVMA established a long-distance telephone discount program with Telcom Advantage Group, an aggregator of AT&T services. Although the program has provided significant discounts to those members whose accounts were activated, the program as a whole has failed to meet expectations. Many members who applied for the program service experienced long delays before they were activated, and some suffered interruption of all long-distance service for several days to two weeks. Although residential service was promised, AT&T limited availability only to business lines, and AT&T has significantly increased the applicable tariff rates.

Therefore, AVMA has terminated the original program and has, after considerable study, entered an agreement with US Sprint to offer discount long distance services for members' business and residential telephones. The 5% discount on Sprint's low rates now provides a greater savings than the original program at the current rates. Sprint offers responsive service and a range of service options that are available with one telephone call. Members should call 1-800-473-0898 to enroll or to secure further information about the program.

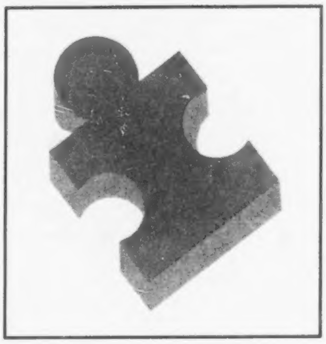
The AVMA is continuing to seek other opportunities to provide quality services to its members at favorable prices.

Career Development Center

The Career Development Center organized a full-day program on careers at the Seattle AVMA meeting. The program included information on how to write a cover letter and resume; how to survive an interview; positions in industry, administration, and management; and how to change careers. A *Career Development and Placement Manual* was developed and distributed with information on obtaining positions in the federal government and career opportunities in veterinary medicine.

The Symposium on Public and Corporate Veterinary Medicine at College Park, Maryland on September 15-17, 1991 provided vital information on characteristics, attributes, and qualifications needed for positions in public and corporate veterinary practice. Participants agreed that oral, written, and computer communication skills were essential for positions in industry and the government. Being a team player also was identified as an essential characteristic. A list of unmet opportunities (positions that veterinarians could but are not filling) was developed. The Symposium Proceedings were published in the February 1, 1992 issue of *JAVMA*.

A new brochure that explained the Placement Service of AVMA's Career Development Center is now available.



The profession's response to the Placement Service continues to be phenomenal. In the past year, the Placement Service provided on-site services at the following national veterinary meetings: AVMA, Eastern States Veterinary Conference, Western Veterinary Conference, American Association of Swine Practitioners, American Animal Hospital Association, Central States Veterinary Conference, American Association of Bovine Practitioners, and American Association of Equine Practitioners.

Through the Placement Service, firms, institutions, and veterinary practices, which sought services of a veterinarian, a relief veterinarian, or a veterinary technician, found qualified candidates. Veterinarians who sought a new position, a postgraduate program, or a career change found suitable opportunities. Placement services also were available to veterinary students and veterinary technicians.

Career Opportunities Centers were presented at the AVMA meeting in Seattle, the Student AVMA Symposium in Madison, Wisconsin, and the Symposium on Public and Corporate Veterinary Practice in College Park, Maryland. The Centers provided information about career opportunities in aquatic medicine, Animal and Plant Inspection Service, Food Safety and Inspection Service, Peace Corps, and US Public Health Service: Centers for Disease Control, Food and Drug Administration, and National Institutes of Health.

During 1991, senior veterinary students participated in AVMA-funded precepteeships at the Center for Disease Control, National Animal Disease Center, and AVMA's Governmental Relations Division. The Placement Service also listed other precepteeships with the Animal and Plant Inspection Service, Animal Health Institute, industry, and private clinical practices.

Information on career opportunities in veterinary medicine was published in *Working Woman* magazine, the *New York Times*, the *Chicago Tribune*, and *Connections*, a magazine for college-age American Express card holders. An advertisement "Here's your opportunity to be a veterinarian—a scientist and a leader on the animal health team" appeared in the *Directory of the National Association of Advisors for the Health Professions*.

AVMA Governmental Relations Division

Veterinarians and organized veterinary medicine jumped into the 1990s with a very active year of political participation. AVMA's Governmental Relations Division (GRD) enjoyed a year of unsurpassed growth and rising influence in our nation's

Reports on Wildlife and Laboratory Animals

Prevalence of *Toxoplasma gondii* infection in raccoons

J. P. Dubey, MVSc, PhD; A. N. Hamir, BVSc, PhD; C. A. Hanlon, VMD;
C. E. Rupprecht, VMD, PhD

Summary: *Serum samples from 427 raccoons (93 from Pennsylvania, 45 from New Jersey, 72 from South Carolina, 68 from Virginia, 30 from Iowa, and 119 from Ohio) were evaluated for* Toxoplasma gondii *antibodies in dilutions of 1:25, 1:50, and 1:500. The distribution of* T gondii *antibody titers was < 1:25 for 212 raccoons (49.6%), 1:25 for 34 raccoons (7.9%), 1:50 for 117 raccoons (27.4%), and ≥ 1:500 for 64 raccoons (14.9%). Tissue cysts were seen in the liver, and tachyzoites were in the brain of a raccoon with abnormal neurologic signs and concurrent infection with canine distemper virus. Organisms in the liver were stained with anti-*T gondii *serum, and the raccoon had a* T gondii *titer of 1:160 in the agglutination test.*

Table 1—Prevalence of Toxoplasma gondii *antibodies in raccoon sera*

State	Area or county	No. tested	% sero-positive	Antibody titers <1:25	1:25	1:50	≥1:500
Pennsylvania	Philadelphia	28	...	4	1	15	8
	Delaware	13	...	6	0	5	2
	York	3	...	2	0	0	1
	Dauphin	1	...	0	0	1	0
	Centre	48	...	36	3	8	1
Sub Total		93	48.3	48	4	29	12
New Jersey	Coastal Delaware River	45	73.3	12	1	19	13
South Carolina	Bull Island	72	34.7	47	4	10	11
Ohio	Southeastern	119	56.3	52	10	41	16
Virginia	Parramore Island	68	36.7	43	6	10	9
Iowa	unknown	30	66.6	10	9	8	3
Total		427	50.3	212	34	117	64

Infection by the protozoan parasite, *Toxoplasma gondii*, is prevalent in many warm-blooded species, including human beings.[1] As omnivores, raccoons are considered good monitors of environmental contamination.[2] The purpose of the study reported here was to determine the prevalence of *T gondii* infection in raccoons from Ohio, New Jersey, Delaware, Virginia, Iowa, and Pennsylvania and document *T gondii* in histologic sections of tissues from a raccoon with abnormal neurologic signs.

Materials and Methods

Serologic prevalence of T gondii *in raccoons*—Serum samples from 427 raccoons from Pennsylvania, New Jersey, Ohio, South Carolina, Iowa, and Virginia (Table 1) were obtained as part of a project on the development of oral wildlife rabies vaccination.[3,4] Sera were examined for *T gondii* antibodies, using formalin-preserved tachyzoites in the agglutination test.[5] Three dilutions (1:25, 1:50, and 1:500) of survey sera were tested.

Case report—A juvenile male raccoon, in a residential, rabies endemic area of Philadelphia, Pa, was observed to have abnormal neurologic signs. The raccoon appeared to be unaware of its surroundings. It was trapped live by local animal control personnel as a rabies suspect, was euthanatized, and submitted to the Wistar Institute for rabies diagnosis. At that time, it was noticed that the raccoon had an ear tag indicating that it had been vaccinated for rabies and had been trapped a week before when it was observed to be healthy.

A complete necropsy was performed. Cervical spinal cord, salivary glands, and blood from the heart were collected for fluorescent antibody testing, virus isolation, and serum neutralization testing for rabies virus. Serum also was used for detection of *T gondii* antibodies, using formalin-preserved antigen in the agglutination test.[5] The serum sample was diluted 2 times up to 1:2,048.

The brain and portions of the heart, diaphragm, tongue, masseter muscle, esophagus, lung, liver, kidney, pancreas, spleen, skin, mesenteric

From the Zoonotic Diseases Laboratory, Livestock and Poultry Sciences Institute, Agricultural Research Service, USDA, Rm 104, Bldg 1040, BARC-East, 10300 Baltimore Blvd, Beltsville, MD 20705-2350 (Dubey), Department of Pathobiology, School of Veterinary Medicine, New Bolton Center, University of Pennsylvania, Kennett Square, PA 19348 (Hamir), and Wistar Institute, Philadelphia, PA 19104-4268 (Hanlon, Rupprecht).

Supported in part by a grant from Pennsylvania Department of Agriculture.

The authors thank Eva Kovacs, B. Lehmenn, S. Hindman, M. Coicou, J. Dieter, R. Buchanan, S. Sanley, and W. Adler for technical assistance.

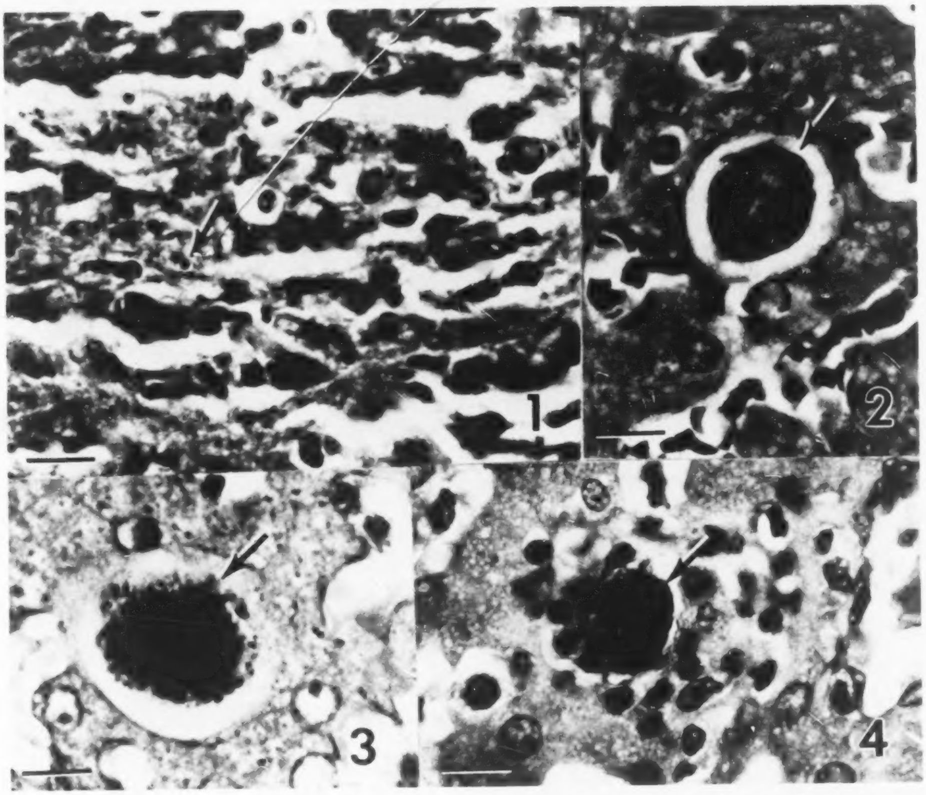


Figure 1—Photomicrographs of Toxoplasma gondii *in the brain (Part 1) and liver (Parts 2-4) of a raccoon. Scale bar for Fig 1 = 13.3 μm. Part 1—Arrow points to a tachyzoite.* H&E *stain. Part 2—Arrow points to a tissue cyst.* H&E *stain. Part 3—A tissue cyst (arrow). Periodic acid-Schiff hematoxylin. Part 4—A group of tachyzoites (arrow) surrounded by mononuclear cells. Avidin-biotin complex immunohistochemical stain.*

lymph node, stomach, intestines, urinary bladder, prostate gland, testicles, salivary glands, aorta, adrenal glands, eye, and the cervical spinal cord were fixed in neutral buffered 10% formalin for histologic evaluation. Paraffin sections of liver were reacted with anti-*T gondii* and anti-*Neospora caninum* sera as described.[6]

Results

Antibodies to *T gondii* were found in 50.4% of raccoon sera (Table 1).

The raccoon carcass described in the case report was emaciated and dehydrated. The lungs did not completely collapse when the thorax was opened. There were multifocal grayish, firm lesions (up to 4 mm in diameter) in the parenchyma of the lung. The gastrointestinal tract was empty of ingesta, but 5 adult *Baylisascaris procyonis* were seen in the intestines. The liver contained randomly distributed 1- to 2-mm, pale white lesions. The brain was excessively moist, but was otherwise normal.

In the cerebrum, cerebellum, and the brain stem, randomly distributed foci of gliosis and mononuclear cell infiltrations were seen microscopically. In 1 focus, a few *T gondii* tachyzoites were seen (Fig 1). The meninges were infiltrated with mononuclear cells.

The liver had many randomly distributed small foci of necrosis and infiltrations of inflammatory cells, predominantly macrophages. *Toxoplasma gondii* tissue cysts and tachyzoites were seen in hepatocytes (Fig 1). Organisms in liver stained with anti-*T gondii* serum but not anti-*N caninum* serum in an immunohistochemical test[6] (Fig 1).

The lungs had multifocal to coalescing granulomata attributed to infection with a nematode, *Crenosoma* sp. Elsewhere in the lungs, the alveolar septa were thick and some of the lining epithelial cells had eosinophilic cytoplasmic inclusions. The mesenteric lymph nodes were edematous, extremely hypocellular, and only a few small remnants of lymphoid follicles could be identified in the tissue section. The epithelial cells of the stomach, prostate gland, and epididymis had small eosinophilic cytoplasmic inclusions that were similar to those seen in the epithelial lining cells of air-passages in the lungs. A few, similar eosinophilic inclusions were seen in some of the glial cells in the brain; however, these inclusions were predominantly intranuclear. The cytoplasmic and the intranuclear inclusions resembled viral inclusions of canine distemper.

Numerous sarcocysts of *Sarcocystis kirkpatricki*[7] were seen in diaphragm, tongue, masseter muscles, and eosophagus. Additionally, 5 sarcocysts were seen in the cerebellum. Lesions were not seen associated with sarcocysts in the CNS.

The *T gondii* antibody titer in the raccoon serum was 1:160. Rabies virus antigen was not detected in the raccoon's brain. The result of the serum neutralization test for rabies virus was negative.

Discussion

Although the seroprevalence of *T gondii* in raccoons in this survey was approximately 2 to 3 times higher than in previous reports,[8-10] the data are not strictly comparable because of differing techniques and survey samples. Dye-test antibodies (≥ 1:16) were found in sera of 23.4% of 77 raccoons from Maryland[8] and 33% of 67 raccoons from Georgia.[9] Walton and Walls[9] also isolated viable *T gondii* from 4 of 50 raccoons from Georgia. Burridge et al[10] found indirect hemagglutination antibodies (≥ 1:64) in 18% of 530 raccoons from Florida. The sensitivity and specificity of these serologic tests for diagnosis of toxoplasmosis have not been evaluated in sera from raccoons inoculated with *T gondii*; however, the agglutination test has been found generally more sensitive than the dye test.[1] The indirect hemagglutination has been found to be the least sensitive test when sera from other experimentally infected animals are used.[1]

The seroprevalence of *T gondii* in the present study may be higher than reported because we considered a titer of 1:25 as positive, and other data were not available as a guide for determining what titer is diagnostic in raccoons. Seroprevalence data in raccoons indicate a heavy contamination of the environment by *T gondii*, and these data should serve as baseline data to monitor environmental contamination by *T gondii*.

Results of routine histologic study in raccoons (data not shown) indicated that *T gondii* organisms are rarely observed in tissue sections, whereas *Sarcocystis* sarcocysts are found in approximately half the raccoons studied histologically; sarcocysts have not been reported from the brain of raccoons.[7] The raccoon of the clinical case described in this report had evidence of distemper virus infection, which may have attributed to immunosuppression leading to recrudescence of a latent *T gondii* infection. The identification of well-developed tissue cysts in the liver supported this hypothesis. Although *T gondii* does encyst in visceral organs,[1] most tissue cysts are found in the brain and muscles; therefore, the finding of tissue cysts in the liver of the raccoon was unexpected. The role of *T gondii* and canine distemper virus in inducing abnormal neurologic signs could not be determined in our study. Only a few *T gondii* tachyzoites were seen in lesions. The low *T gondii* antibody titer (1:160) did not aid diagnosis.

Clinical toxoplasmosis was reported only once in the literature in 2 raccoons.[11] One raccoon had meningoencephalitis, and the other had interstitial pneumonia in association with *T gondii*-like organisms. Both raccoons also had distemper virus infection. However, because isolation and serologic examinations were not made, the diagnosis could not be confirmed.

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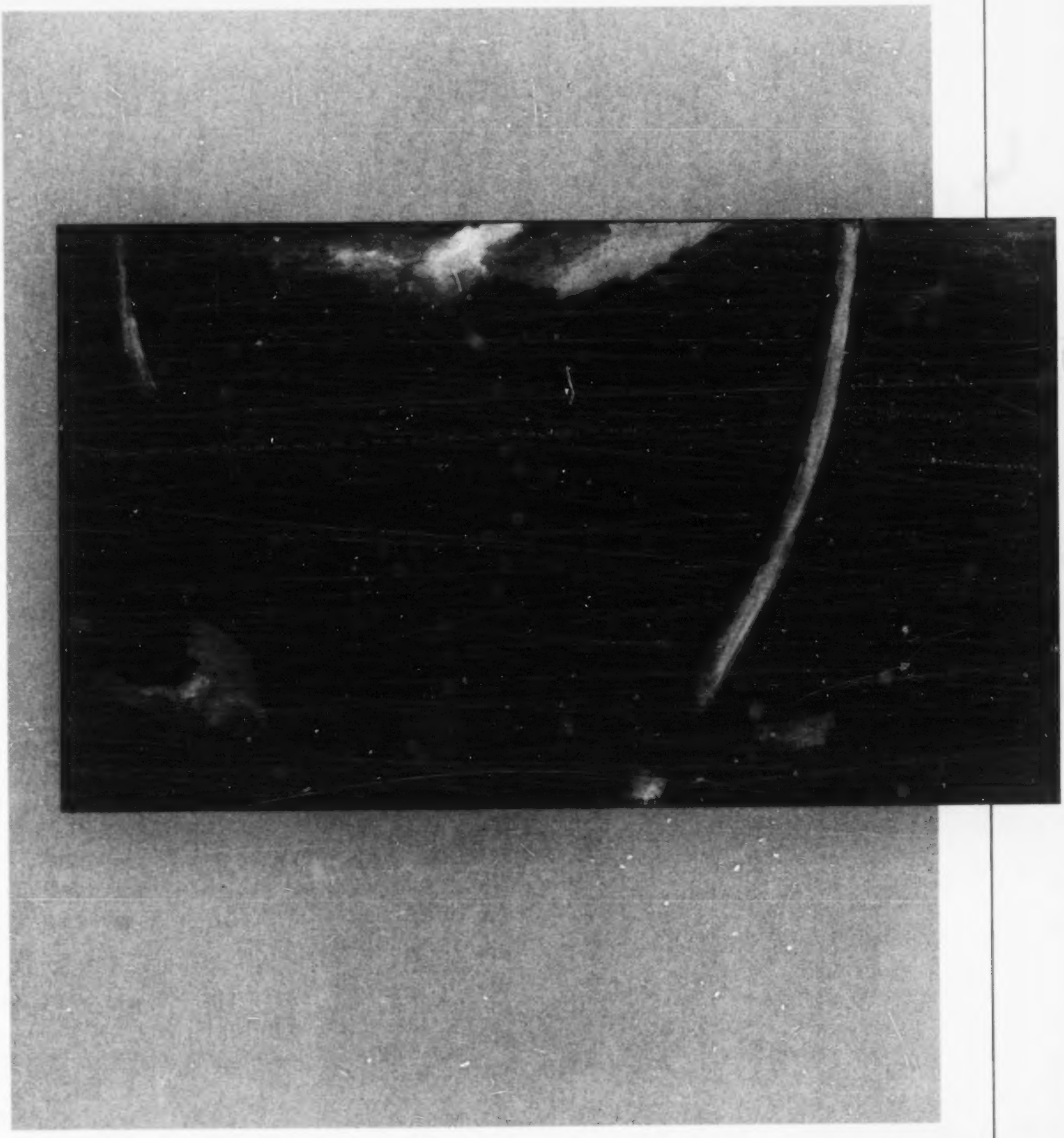
A3100-2

March 1, 1992, Volume 200, Number 5

JOURNAL

OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION



JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 200 March 1, 1992 No. 5
JAVMA 200 (5) 577-752 (1992)
ISSN 0003-1488

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Die grossen blauen Pferde (The Large Blue Horses) was painted in 1911 by German artist, Franz Marc (1880-1916). This 41⁵⁄₁₆- × 71¼-inch oil-on-canvas is in the collection of the Walker Art Center, Minneapolis. It was a gift of the T. B. Walker Foundation, Gilbert M. Walker Fund, 1942.

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SUBSCRIPTIONS: For one year: members $50; others $100 in the United States and possessions; $120 in foreign countries. Single copies: $6.00 in the United States and possessions; $8.00 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

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BPA

Professional burnout among female veterinarians in the United States

A. D. Elkins, DVM, MS, and Michael Kearney, MS, MA

Dr. Susan G. practices veterinary medicine in Atlanta, Ga in a busy small animal hospital with two male colleagues. She is married to an accountant and has a four-year-old son. She has been with the same practice since she graduated from veterinary school 6 years ago. Susan dreamed of being a veterinarian since the age of twelve. As a youngster she loved animals and owned a horse. Her father, a hard-driving successful dentist, encouraged her to pursue a career in the medical field. Susan was an ideal student in veterinary school and graduated in the top 5% of her class. She maintained these same high standards as she began her practice career. Susan quickly discovered that women in her graduating class were offered $2,000 to $4,000 less per year than their male counterparts. She continued to experience this financial discrimination in her current position. Susan had begun to feel the pressures of working 40 to 45 hours per week as a veterinarian and being a full-time mother and wife.

Susan is a good veterinarian with high professional standards. Everyone agrees that her goals are worthy and admires her for maintaining the dual role of professional and mother/wife. To all appearances, Susan is a 20th-century success story. However, Susan is on the brink of professional burnout.

Burnout is best described as a state of emotional exhaustion, in which work becomes routine and mechanical. Burnout is often accompanied by feelings of disenchantment toward work and hostility toward clients and their problems. It is accompanied by feelings of anger expressed in a negative, cynical attitude toward others, particularly clients. Clients are objectified and treated as subjects or cases rather than people.

Burnout syndrome can be identified with four Ds: disengagement, distancing, dulling, and deadness.[1] The burned-out individual may change positions or jobs, continue to work in a robot-like fashion, or discontinue work completely.

Our society exerts pressure on women to assume family responsibilities, such as child rearing, which may influence the rate at which they experience burnout. Studies have shown that female physicians have higher negative responses to the conflicting roles of family and professional responsibilities than do male physicians.[1] The decision for a woman to enter a "man's profession," such as veterinary medicine has only recently become socially acceptable. Because of a rapid gender shift from 1971 to 1987, 22% of the total number of veterinarians in 1990 were women. In 23 colleges of veterinary medicine for 1988 to 1989, 57% of the veterinary students were women.[2]

The purpose of the study reported here was to determine the stress and burnout level of female veterinarians throughout the United States. An attempt was made to draw various comparisons between this survey and a similar survey that was completed in 1981 with 95% of the respondents being male veterinarians.

Background

The exact causes and sources of burnout are unknown, although social psychologist, Dr. Christina Maslach,[1-5] and psychoanalyst, Dr. Herbert Freundenberger,[6-8] through research and clinical work, respectively, are beginning to outline the essential features of burnout. Burnout can be traced to self-images formed in early childhood.[6] During those early years, one has a variety of psychological needs that are satisfied when that person adopts certain forms of behavior. Children receive psychological support for being "the little helper," "the rescuer," "a big little man," "the smart one," or "good." One or more of these roles and the self-images associated with them become the foundation for the hard working, competent, dedicated and idealistic professional person.

Professionals become prime candidates for

From the Indiana Veterinary Surgical Referral Service, 8250 Bash St, Indianapolis, IN 46250 (Elkins), and the Department of Epidemiology and Community Health, College of Veterinary Medicine, Louisiana State University, Baton Rouge, LA 70803 (Kearney).

burnout if their idealistic, competent, vague (and perhaps perfectionistic) self-images conflict with other parts of themselves that have been suppressed over the years. There is a strong possibility that students cut themselves off from many of their feelings to realize their goal of becoming highly professional veterinarians. Many female veterinarians feel the pressure of being full-time professionals while wanting to spend more time with their families. One may become a victim of burnout if the disparity between self-image and inner self is great enough.

The childhood foundation for burnout is reinforced in the educational process. Extensive professional training results in a series of short-term gratifications followed by long-term deprivations. The graduating college senior feels great that she has accomplished a goal, only to become a freshman veterinary student. Upon graduation as a veterinarian, she begins her first position of employment and again finds herself at the bottom of the heap. At this time, she is faced with the realities of professional responsibilities and the world of economics. By diligent work, young professionals adapt and begin to cultivate successful practices. However, the stress and pressures of constantly dealing with clients, colleagues, and staff begin to take their toll, and signs of burnout may appear. The personality traits that characterize a good professional are also traits that predispose people to burnout. These traits include control of emotional expressions, exacting attention to detail, conscientiousness, and prolonged deferral of gratification.[2] Extensive work has been done on the response of women physicians to the conflicting dual roles of family and profession,[9-11] but to our knowledge, nothing has been published on female veterinarians.

Table 1—Demographic characteristics of the respondents

Characteristic	Percent
Race or ethnicity	
White	98.7
Black	1.3
Asian	0.6
Hispanic	0.6
Other	0.8
Marital status	
Married	57.5
Single	33.0
Divorced or separated	9.5
Age	
30 and younger	24.4
31 to 35	41.8
36 to 40	23.4
41 to 45	6.6
46 and oldc.	3.8
Number of children	
0	66.8
1	13.2
2	14.5
3	3.7
4 or more	1.8
Number of job changes since graduation	
No job change	25.0
1	21.8
2	18.7
3	18.3
4	9.4
5 or more	6.8
Current type of job position	
Small animal	63.0
Small animal/large animal	13.9
Large animal	5.3
Academia	8.4
Industry	3.1
Government (military, state, federal)	4.7
Not working	0.9
Working but outside veterinary medicine	0.7
Average number of hours worked per week	
20 or less	5.4
21 to 30	6.9
31 to 40	19.2
41 to 50	35.9
51 to 60	23.6
61 or more	9.0

Survey of burnout in female veterinarians

A questionnaire designed as an instrument for self-diagnosis of burnout, along with a letter of explanation, was mailed to 1,000 female veterinarians in the United States. These veterinarians were selected at random from the AVMA mailing list by region of the country. The subjects were asked to provide information about their work habits and other information that might be correlated to burnout. They were also asked to complete a burnout self-diagnosis instrument devised by Pines[4] (Appendix). All scores were confirmed by computer calculation. The extent of burnout was determined by use of Pines and Maslach's self-diagnosis scale.[4]

The data was analyzed by use of the SAS statistical package.[a] The analyses were performed by defined geographic region and results were combined over all regions. In all cases of inferential tests of hypothesis, the dependent variable consisted of burnout score, and independent variables included other elements in the survey instrument that were hypothesized to affect burnout score. In an attempt to remove the source of variation attributed to year of graduation, this variable was included as a covariate in the analyses of variance. All tests were considered significant at a probability level of $P < 0.05$.

The burnout scale yields scores of 1 to 7. A score of 1 to 2 indicates low levels of stress and dissatisfaction with work; a score of 2 to 3 indicates that the respondent generally feels good about herself with acceptable levels of stress and a manageable level of work dissatisfaction; a score of 3 to 4 indicates the beginnings of the burnout syndrome and the need to reexamine work and life priorities; a score of 4 to 5 indicates a state of clinical burnout and changes in work and life-style are imminent; a score of 5 to 6 is approaching a level of burnout where professional counseling is needed, and a score of 6 to 7 indicates severe burnout and the probable impairment of professional performance.

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[a] Base SAS software, SAS Institute, Cary, NC.

Results

A total of 613 (61%) female veterinarians responded to the survey. Five hundred seventy-two of the questionnaires returned were complete enough to be included in the study (Table 1).

Geographic regional effect was not revealed by any of the analyses performed. Correlation analysis indicated significant correlations between burnout score and happiness level, equal treatment, and choice of veterinary profession, which were all negatively correlated ($r = -0.55, -0.22, -0.33$, respectively), and between burnout score and hours per week ($r = 0.146$) and stress ($r = 0.38$). These results were further corroborated in the stepwise regression analysis wherein the best four-variable predictive model consisted of happiness, stress, choice, and hours per week, listed in order of decreasing importance in the model ($R^2 = 0.44$). Analysis of variance indicated that being a practice owner was the only significant variable affecting mean burnout score, in that owners recorded significantly lower scores than nonowners.

The average age of the women responding to the survey was 34 years. Fifty-eight percent of the respondents were married, and 67% had no children. Ninety percent graduated after 1970, with a mean graduation date of 1984. Twenty-one percent of the women had acquired board certification or formal training following veterinary school.

Eighty-two percent of the women were in practice; 63% were in exclusively small animal practices. Of the women in practice, 22% were owners of a one-veterinarian practice, 9% owned a multiple veterinarian practice, 12% were in a partnership, and 57% were employees of other veterinarians. Fifty-four percent had changed jobs 2 or more times since graduation, with a mean of 1.9 job changes. Sixty-nine percent worked 40 hours or more per week, with a mean of 47 hours per week. Seventy-six percent of the practices had 3 or fewer veterinarians with a mean of 2.9 veterinarians.

The women were asked to rate their response to four statements, using the Likert scale, with ratings 0 to 5, where 0 = no opinion, 1 = strong disagreement, and 5 = strong agreement, with 2, 3, 4 falling between strong disagreement and strong agreement. The four statements were:

1) I am happy in my current position!
2) Women are treated equally to men in the veterinary profession!
3) If I had the choice to make again I would choose the veterinary profession!
4) I consider my position stressful!

Eighty-three percent, 71%, and 87% scored 3 or above on the scale indicating they agreed or strongly agreed with statements 1, 3, and 4, respectively. Eighty percent scored 3 or below on the scale, indicating they disagreed or strongly disagreed with statement 2.

The respondents ranked potential stressors in practice from 1 to 6, with 1 being the most stressful, and 6 being the least stressful. Managing the practice was ranked as the number 1 stressor, economic concerns ranked as number 2, client relations as number 3, lay staff relationships as number 4, professional relationships as number 5, and personal/family relationships as number 6.

The mean burnout score of the 572 women respondents was 3.41 (range, 1.81 to 6.14). There was no difference in burnout score from the five geographic regions. The distribution of the burnout scores and percentage of respondents were as follows: 3% scored 1 to 2; 29.8% scored 2 to 3; 43.1% scored 3 to 4; 21.5% scored 4 to 5, and 2.6% scored >5.

Discussion

Many articles have been written in human medicine as to the effects of stress on female physicians.[9-11] Most psychologists agree that ability to cope with stress relates to personality type and childhood experience. For most people, the development of personality values and the crystallizing of life choices begins early in childhood. Girls in our culture are usually encouraged to choose more passive types of activities because these are considered to be more feminine and more consistent with their later roles. Scientific pursuits in particular are frowned on and considered to be masculine because of their association with assertiveness, precision, and responsibility. In the process of growing up, girls find that they need to deny aggressive traits even when they are actually functioning in areas in which these skills are necessary. There are blatant inconsistencies between the passivity and compliance expected of women in relation to men, and the activity and authoritativeness expected in the role of wife and mother.

A girl who is interested in medicine and who comes from a conventionally structured middle-class family may face conflict between her identification with her mother and her interests in a different pattern of life. If her relationship with her mother is close and relatively unconflicted, she may have difficulty because she may see herself as betraying her mother and competing with her to achieve more. If a woman has had a troubled relationship with her mother, she may become uncomfortable in seeking a demanding career because this interest may seem connected with the problems in the relationship as opposed to being a true career interest. A girl's identification with her father's professional role may promise an easier pathway for the development of her own serious career interests, but it may interfere with her relationship with her mother and with the resolution of identity issues. A man may have analogous conflicts, but more external supports are available to him to facilitate the resolution of problems of career choice.[11]

The structure of the medical profession has traditionally been organized by men who devoted their prime years to academic achievement or to building successful practices. Meanwhile, many of their wives stayed home managing children and household responsibilities. There are exceptions to this where the wife has built a career or a female physician has maintained a dual role of wife/mother and professional. Traditional role models pressure women to bear the burden of child care and perform most of the household chores. This social pressure, in addition to the professional career structure of medicine, make it extremely difficult for a woman to maintain multiple roles of wife, mother, and veterinarian. The period of intense career building coincides with a woman's peak biologic childbearing years. Therefore, to expect that women's careers should follow the same course as those of men is unreasonable.[9] In one study,[10] it was found that 80% of female physicians surveyed thought that having children had slowed their career progress. Although this information comes from the human medical field, much of it is applicable to female veterinarians.

In our survey, 67% of female veterinarians scored 3 or above on the burnout scale. This is the point at which clear-cut signs of the burnout syndrome occur. This 67% scoring above 3, with a mean burnout score of 3.41, compares with results of a nationwide survey of primarily male veterinarians in 1981, using the same burnout instrument, in which 53% scored above 3, with a mean burnout score of 3.09.[12]

Significant correlation was observed between higher burnout scores and veterinarians responding negatively to the following statements: I am happy in my current position; Women are treated equally to men in the veterinary profession; and If I had the choice to make again I would choose the veterinary profession. This result was expected because individuals feeling negatively about their profession would be expected to score higher on the burnout scale.

Women who worked over 40 hours per week and felt their jobs were stressful scored significantly higher burnout scores. This was also observed in the 1981 survey of male veterinarians.

An unexpected finding was significantly higher burnout scores in employed female veterinarians who were not involved in ownership of the practice. This leads one to think that the responsibility and problems associated with ownership and management of a practice do not add undo stress to the lives of female veterinarians. Likewise, being an employed veterinarian with no input into the business aspect of the practice and little control over her future leads to higher burnout scores.

A survey of this type has inherent problems with determining whether it is measuring burnout from occupational stress or burnout associated with personal factors. The high correlation of burnout scores with 87% of the respondents feeling their job was stressful suggest that the scale did, in fact measure work-related factors. Another factor to consider is that 397 women did not respond to the survey. Were the nonrespondents the most burned-out individuals, and so they failed to respond to the survey, or were they those successfully coping with stress and therefore believed responding was not necessary? Ideally a second and third contact with these nonrespondents should have been attempted, but was not done at this time.

What conclusions may be drawn from this survey? Female veterinarians did score higher on the burnout scale than did male veterinarians in a previous survey.[12] The reason for this was not determined, but assumptions can be made that personal and home responsibilities along with lower salaries contributed to this higher score. Eighty-three percent of the women were satisfied with being veterinarians and in their job position. This agrees with results of a recent study of female veterinarians in Texas in which 79% reported being happy in their veterinary career.[13] However, most of these women thought they were not treated equally to men in the profession. This is reflected in lower number of job offers to women and lower salaries than men.[14] For women practicing veterinary medicine, starting salary averaged $4,433 less than that of the men.[14]

Forty-two percent of the women were involved in ownership of their practices. Managing the practice and economic concerns were the most stressful factors reported. In another study, it was reported that women and men who graduated from veterinary school prior to 1970 experienced a higher degree of enjoyment from their practice than did those who graduated in the 1970s or 1980s.[13] In our survey, only 3.1% of the respondents graduated prior to 1970, so no conclusions could be drawn. Seventy-one percent said they would choose the veterinary profession again if they had that decision to make.

Women currently comprise over 50% of graduating veterinarians. Because of personal and family responsibilities, demands on female veterinarians are greater than those on male veterinarians and may require schedule adjustments. These factors should be considered and addressed during the professional educational process. Female role models and mentors should take an active role in counseling and advising students of successful coping strategies for the prevention of burnout. Although women in this survey did score higher than men in another survey, most were happy in the profession while working over 40 hours per week.

Appendix

Burnout self-diagnosis instrument
All Participants please complete the following self-diagnosis instrument. (You do not have to compute your score).

Veterinarians can compute their burnout score by completing the following questionnaire, using the following scale:

1	2	3	4	5	6	7
Never	Once in a great while	Rarely	Sometimes	Often	Usually	Always

How often do you have any of the following experiences?

__________ 1. Being tired.
__________ 2. Feeling depressed.
__________ 3. Having a good day.
__________ 4. Being physically exhausted.
__________ 5. Being emotionally exhausted.
__________ 6. Being happy.
__________ 7. Being "wiped out."
__________ 8. Feeling "burned out."
__________ 9. Being unhappy.
__________ 10. Feeling rundown.
__________ 11. Feeling trapped.
__________ 12. Feeling worthless.
__________ 13. Being weary.
__________ 14. Being troubled.
__________ 15. Feeling disillusioned and resentful about people.
__________ 16. Feeling weak.
__________ 17. Feeling hopeless.
__________ 18. Feeling rejected.
__________ 19. Feeling optimistic.
__________ 20. Feeling energetic.
__________ 21. Feeling anxious.

Computation of score:
Add the values you wrote next to the following items:
1,2,4,5,7,8,9,10,11,12,13,14,15,16,17,18,21 = _____(A).
Add the values you wrote next to the following items:3,6,19,20 = _____(B).
Subtract B from 32: 32 − B = _____(C).
Add A and C = _____(D).
Divide D by 21 = _____. This is your burnout score.

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Zoo veterinarians—doctors on the ark?

R. Eric Miller, DVM

In a corner of the Cincinnati Zoological and Botanical Gardens stands a small, restored pavilion. Its displays contain no living animals, but rather the preserved bodies of the last passenger pigeon and the last Carolina parakeet. Both died there during World War I, the last representatives of species driven to extinction by human interference outside of the zoo's boundaries. Next door, "living" exhibits feature Cincinnati's large breeding group of gorillas and a feline house specializing in small, endangered exotic cats. As wild habitats and animals become increasingly threatened, the juxtaposition of facilities is appropriate. Many of the more than 104,000,000 annual visitors to North American zoological institutions[a] fail to realize that numerous zoo "favorites", such as Siberian tigers *(Panthera tigris altaica)*, Asian elephants *(Elephas maximus)*, and orangutans *(Pongo pygmaeus)*, are endangered in the wild and are subjects of intensive captive breeding programs.[1] Yet other species, such as California condors *(Gymnogyps californianus)* and black- footed ferrets *(Mustela nigripes)*, have depended on captive breeding programs for their very survival.

As zoological parks remain centers for public entertainment and pleasure, via education, research, and breeding, they have also become conservation centers. In this role, fulfilling basic animal welfare needs lays the cornerstone for the ultimate animal welfare issue, that of preventing the extinction of species.

As medical personnel and as part of a larger team of zoo professionals, veterinarians have a key role in animal welfare at zoological institutions. As recently as 1982, Robert Bendiner wrote, "until the last decade, a resident veterinarian was the rarest animal to be found in the zoo."[2] Today, the situation has changed greatly, because nearly every major zoological facility has a full-time veterinarian. Many have staffs that include several clinical veterinarians along with nutritionists, pathologists, behavioralists, and reproductive researchers (Fig 1). Indeed, Dr. David Wildt, a reproductive researcher at the National Zoological Park, has suggested that advances in veterinary medicine (especially capture, restraint, anesthesia, and medical management) have had key roles in changing and expanding the direction of (zoo) research programs.[3]

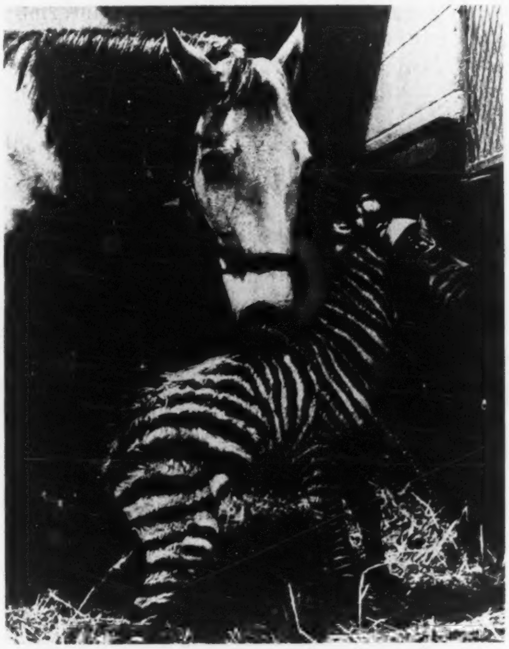

Figure 1—Quarter Horse mare and newborn zebra delivered by the mare as a result of an embryo transfer procedure. Reprinted with permission from the Courier-Journal *May 17, 1984;A-12. Photograph by Paul Schuhmann.*

Veterinary concerns in animal welfare are wide-ranging. Historically, the identification and treatment of disease in individual animals and species in each institution were central to the veterinarian's role in animal welfare. Catastrophic epizootics of infectious disease, such as rhinotracheitis in clouded leopards *(Neofelis nebulosa)* and parvovirus in South American canids, reinforced

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From the St Louis Zoological Park, 1 Government Drive, Forest Park, St Louis, MO 63110-1396.

[a] For this paper, the terms "zoological park (zoo)" and "aquarium" will refer to the 160 accredited members of the American Association of Zoological Parks and Aquariums. Nearly all major public and private zoological institutions are members.

the importance of these activities.[4,5] But zoo veterinarians' interest has expanded beyond diagnosis and treatment of individual animals, and includes the evaluation of populations and preventive medicine, a situation more similar to the orientation of wildlife veterinarians.[6]

In zoological institutions, prevention of disease is critical because the untamed nature of the patients makes intensive treatment of many species difficult if not impossible. Preventive medicine programs include vaccinations (eg, lions and tigers for feline respiratory viruses), parasite surveillance (monitoring gorillas for *Balantidium coli* or orangutans for *Strongyloides* sp), testing for tuberculosis and the communicable diseases, and routine quarantine of new arrivals to prevent introduction of disease into an established animal collection. Preventive medicine in zoological parks also includes identification of environmental factors that may make captive species more susceptible to opportunistic pathogens.[7]

Animal welfare in zoological institutions is regulated by several government agencies. The Animal Welfare Act, which covers animal food, housing, health and safety, is central to this regulation. Since 1970, its enforcement in zoological parks has been carried out by USDA inspections of the more than 1400 facilities that have a USDA license to exhibit animals.[8] The USDA provisions include exotic animals, but exclude birds, reptiles, amphibians, fish, and certain domestic and laboratory-bred mammals.[8,9] The Animal Welfare Act also regulates animal transport and its most recent amendment addresses the psychological well-being of primates.

Veterinarians are central to the inspection process at zoological institutions, both as inspectors and as supervisors. In fact, for the psychologic well-being of primates, the attending veterinarian at the institution is responsible for overseeing application of the Animal Welfare Act standards. Additionally, at institutions with active research programs, veterinarians are integral in the function of Institutional Animal Care and Use Committees. Besides the standards of the Animal Welfare Act, zoos and aquariums have other federal regulations to meet as well. They are subject to the Department of Commerce's Marine Mammal Protection Act of 1972, which specifies housing and water conditions for marine mammals, and the Interior Department's Endangered Species and Migratory Bird Acts that require permits for the maintenance of covered species.[10]

In 1980, the zoological community developed a second, rigorous system of regulation through the accreditation process of the American Association of Zoological Parks and Aquariums (AAZPA). By 1985, all AAZPA institutions had complied or lost membership. Today, 160 North American zoological institutions are accredited members of AAZPA.[1]

The scope of the AAZPA inspections is broader than that of the federal government, for example, all animal species are covered. In addition to food, water, and housing, further attention is given to the social needs of the animals, record keeping, research, and captive propagation of endangered species. By their Code of Ethics, zoos are bound to see that the animals in their care receive humane care. In addition, animals may only be transferred to other institutions that are capable of providing professional care, and if they are euthanatized, it must be done so humanely. The accreditation process also requires cooperation in local, national, and international conservation programs, and the provision of educational programs for the public. Member institutions must file detailed financial statements to demonstrate their ability to provide for the sustained care of the animals in their charge.

Table 1—Comparative rates of species extinctions

Time	Rate of extinction
70,000,000 years ago (disappearance of the dinosaurs)	1 species/1000 years
1 AD to 1650	1 species mammal or bird/82 years
1650 to 1850	1 species mammal or bird/5 years
1850 to 1900	1 species mammal or bird/9.5 months
1900 to 1950	1 species mammal or bird/8 months
Present	All plant and animal life, 1 to 6 species/day
2000 (projected)	All plant and animal life, 1 species/hour

These regulations reflect the concern of zoo professionals, governmental agencies, and the public in the humane and improved care of captive animals. Simply stated by Dr. Morton Silberman, "husbandry that promotes well-being is synonymous with humane treatment."[11] Nutritious feedstuffs, appropriate social groups, and adequate housing all seem obvious requirements. Yet, for animals in zoos, the provision of each is often the result of years of research. For example, many species have evolved complex and specialized feeding strategies, but often these are diets that zoos are still studying and refining.[12]

Increasing knowledge of animal behavior has advanced our concepts of animal welfare and housing.[13] "Postage stamp" exhibits that featured few individuals and large numbers of species have been replaced by more naturalistic displays featuring groups, troops, and other arrangements that parallel a species' natural social structure.[14] Gorillas are an example. They rarely reproduced in pairs, but have been much more fecund when placed in larger troops that mimic their wild society.

At a time when zoos are focusing on breeding endangered species, the preservation of species becomes the paramount animal welfare issue. Arguably, extinctions are part of the natural process of Darwinian evolution, but the current number of extinctions is compounded exponentially by man-made environmental changes and destruction (Table 1).[2,15,16] In this maelstrom of endangerment, zoos are a potential means of survival for some critically endangered species. However, the numbers of endangered species are too overwhelming for zoological institutions to become "arks" for all species (it has been estimated that zoos could manage 2000 vertebrate species).[17]

Responsible zoo professionals readily acknowledge that the first priority is to maintain a species in its native, intact environment. Michael Hutchins, AAZPA Director of Conservation and Science observes, "captive propagation cannot be considered as a panacea for the endangered species problem and should be implemented as part of a more holistic effort to preserve species in their natural habitats."[18] But for many species, political instability (the kouprey, *Bos sauveli* in Cambodia); introduced predators (the Micronesian kingfisher on Guam); introduced disease (the gaur, *Bos gaurus*, in Southeast Asia); poaching for commercially valuable products (the black rhinoceros, *Diceros bicornis*, across sub-Saharan African); and most commonly, massive habitat destruction (all the prosimian primates on Madagascar) create a future threatened by the risk of unnatural extinction. For these and other species, captive breeding may serve as an alternative to extinction until current political and environmental instabilities resolve.[19]

Some captive-bred animals have already been returned to their native habitats. As early as 1907, American bison *(Bison bison)* from the New York Zoological Society were used to reestablish several bison herds in the American West.[20] Today, golden lion tamarins *(Leontopithecus rosalia)* are being reintroduced into Brazilian rain forests, and after being hunted to extinction in the 1960s, captive-bred Arabian oryx *(Oryx leucoryx)* from the San Diego and Phoenix Zoos have returned to Jordan and Oman. But for many captive-bred species, reintroduction remains a distant goal because of continued habitat destruction or political instability in their native areas.[19]

The success of captive breeding programs should not be based solely on reintroductions. Many intensive genetic and nutritional analyses, telemetry trials, and behavioral and disease studies are more readily performed in zoological parks because of the greater accessibility of captive animals. Almost invariably, research in zoos focuses on projects that benefit the animals and their species, producing results that are often applicable to the conservation of captive as well as wild individuals still afield. The scope of zoo-based research is growing; a recent survey reported 388 conservation research projects in zoos of 63 countries.[21] From 1990 to 1991, more than 400 technical articles on wildlife biology and conservation research were published in North America by AAZPA institutions.

Vital to the maintenance of endangered species in captivity is the development of programs that preserve their genetic variability over the long term. The clear challenge is to preserve an animal most like its wild relatives in appearance, fertility, resistance to disease; a product of natural selection, not an artificial subspecies produced by the selection of man. Although 90% of the mammals currently exhibited in North American zoos are captive born,[19] the Asian wild horse *(Equus przewalskii)*, the last truly wild (not feral) horse, illustrates the inbreeding predicament. Bred from captive stock since the turn of the century, in the intervening decades, the head shape of the animals has changed. Thus we question whether we have saved the Asian wild horse, or a semi-domesticated version of it.

To avoid this dilemma, a definition of what constitutes saving a species is necessary. Genetic modeling provides us with one definition, saving a species requires the maintenance of 90% of its genetic variability over the next 200 years or 50 generations.[17] To achieve that goal, on the basis of mathematical models, 250 breeding animals would be needed for most species (for some slower breeding species [eg, Asian elephants], 50 might be enough, for some faster breeding species [eg, elephant shrews], 1000 or more might be required).[17] Because only a relative few individuals of each species are housed in each zoo, cooperation without coordination is insufficient to preserve wild animals in captivity over long periods of time.[19,22]

In North America, coordination has been provided by the Species Survival Plans (SSP) of the AAZPA. Currently the management of more than 60 threatened species is done by a committee (Appendix). The AAZPA has set a goal of 200 SSP committees by the year 2000. Similar programs have been organized in Europe, Japan, Australia/New Zealand, Brazil, Southeast Asia, and Africa. The Captive Breeding Specialist Group, a more than 300-member international committee of the World Conservation Union, oversees the global coordination of these regional programs. Worldwide, animals may be identified and located through another organization, the International Species Information System.

Perhaps the Siberian tiger *(Panthera tigris altaica)* best illustrates the function of a SSP. Today more Siberian tigers live in zoos (600 to 700) than in the wild (estimated 300 to 400). Yet, all of the world's captive Siberian tigers descend from 44 "founder" tigers (wild individuals that were presumably unrelated). In Siberian tigers, as in many species, the founders are not equally represented; some have had more breeding success than others.[19] The St. Louis Zoological Park's Siberian tigers were genetically over-represented and the tiger SSP determined that they should not be bred (a progesterone implant was placed in the female). When space became available, new, genetically under-represented lineages were located (a male tiger from San Diego and a female tiger from the Denver Zoo) and placed together at St. Louis. The match was a success in that breeding took place and 2 cubs resulted (whose future placement will be at the direction of the SSP).

However, problems quickly arise. Space limitations are illustrated by the 1750 spaces for large cats in North American zoos, which is space for SSP programs for 7 species if we accept the assumption of a necessary 250 breeding individuals/species (in reality, such a number usually requires a population at least twice that size).[23] Thus, zoos must select 7 species of large cats in which to invest their finite resources (all the world's zoos would fit within an area the size of Washington, DC).[19,24]

This selection requires wisdom. A form of conservation triage exists, a protocol for selecting species for captive breeding.[25] Priority is given to animals that may be in immediate danger of extinction or that may represent the last living member of genus or taxonomic family. If there is not a reasonable chance of success for captive breeding (eg, has the maintenance of related, nonendangered species been successful?), priority is reduced.

The medical management of these small, captive populations offers unique opportunities for veterinarians. The deleterious effects of inbreeding include the potential for altered resistance to disease.[26] According to Dr. Linda Munson, a veterinary pathologist, diseases could prove to be greater modifiers of small populations in the future than the past because of greater habitat and genetic restrictions.[27]

In part, Dr. Munson's observation is illustrated by the prevalence and high morbidity of feline infectious peritonitis in cheetahs.[28] It is a situation likely compounded by their genetic impoverishment.[26] It is a disease, like several others, that markedly complicates the movement of animals between institutions for genetic purposes. The cheetah SSP Committee has been a leader in the interdisciplinary approach to solving these problems. Its research advisory group contains a nutritionist, geneticist, clinical veterinarian, veterinary pathologist, reproductive physiologist, and behavioralist.

As advisors to SSP and related committees, veterinarians are in a central position to monitor vital statistics and disease trends that affect the growth and survival of a captive population. Their role includes the cataloguing of each species' diseases, establishment of preventive medicine programs, and determining veterinary research needs.

Of vital importance to the future maintenance of genetic diversity is research into the reproduction of endangered species.[29-32] With reproductive physiologists and many others, veterinarians have had an active role in the development of cycle determination, artificial insemination, and embryo transfer, which are steps that will aid in the transfer of genetic material between zoos (and the first step in transferring genetic material from the wild to captivity and vice versa or between parks).

Even at necropsy, SSP veterinarians attempt to establish disease patterns and collect tissues for comparative studies vital to the survival of many endangered species.[27] Species Survival plan veterinarians are one source for central tissue/sera repositories vital for future research. And the demand for veterinary participation is a growing one; one estimate suggests a need for 240 veterinary advisors to SSP and related committees by the year 2000 (presently, there are approximately 100 full-time zoo veterinarians).[6]

As members of some captive populations are being prepared for return to the wild, close attention must be paid to the potential for disease spread (the same is true when wild animals are brought into captivity, or if wild animals are translocated between habitats). As golden lion tamarins are being prepared for reintroduction into the coastal rain forests of Brazil, the problems of infectious diseases and genetic defects (eg, coronaviral hepatitis and diaphragmatic hernias) take on critical importance.[33,34] The issues may be more mundane, but no less important (eg, it is critical that Arabian oryx returning to the Middle East be free of tuberculosis or viral diseases such as bluetongue that reside in the United States). Evaluating such risks is vital to the future success of reintroduction programs. In recognition of this, the Captive Breeding Specialist Group is organizing a seminar that will address these issues (November 1992, Oakland, Calif.).

As wildlife habitats continue to shrink, zoological institutions are extending their view beyond those endangered animals that they maintain within their perimeters. An enviable record of funding field programs (more than $4,000,000 annually[21]) has been achieved by Wildlife Conservation International, a division of the New York Zoological Society. It is being joined by a growing cadre of zoos funding habitat protection and field research (eg, the San Diego Zoo's support for the Darwin Research Station in Ecuador helps breed endangered subspecies of the Galapagos tortoise *[Geochelone elephantopus]*, the Minnesota Zoo's "adoption" of Ujon Kulong National Park in Indonesia protects a reserve that is home to the largest remaining population of Javan rhinoceroses *[Rhinoceros sondaicus]*). In such ways, zoological parks can offer unique opportunities for locally supported institutions to contribute to global conservation.[24]

In a similar manner, zoo veterinarians have a growing role in international conservation. In a forward-looking program, the New York Zoological Society employs a full-time veterinarian to service its field projects. Additionally, Dr. Christen Wemmer has established a zoo school that employs a team of zoo professionals to disseminate zoo management and conservation biology techniques to zoological parks in the underdeveloped world.[35] Zoo veterinarians have been active participants in that program and in Zoo Conservation Outreach

Group, a cooperative organization of 32 North American zoological parks and 15 Central American zoos.

As the wild grows smaller, and zoological institutions expand their horizons, the line between captivity and the wild is often blurred. The plight of black rhinoceroses in their native Africa illustrates the point. After a 90% decrease in black rhinoceros numbers (primarily attributable to poaching), the Kenyan government designed a successful sanctuary program that translocated animals from vast, poorly protected parks to smaller, fenced parks and ranches, areas more readily monitored and defended. In the sanctuaries at Lake Nakuru, Solio Ranch, and elsewhere, black rhinoceros numbers have been growing, but only in areas that have carrying capacities between 15 and 100 animals. The situation is similar for elephants, "the distribution of human and elephant populations has changed from one characterized by human islands in a sea of elephants to increasingly small islands of elephants in a sea of people."[36] In reality, the protective fencing for the rhinoceroses or the isolation created by a sea of people has created "megazoos," complete with the specter of inbreeding. Moving rhinoceroses from zoo to zoo is a large enough task in itself; moving them from sanctuary to sanctuary is even more herculean. Thus the genetic management and reproductive studies in zoological institutions have impact on these populations as well,[37] and new opportunities are presented for the zoological and wildlife communities to share interests on common ground.

Through continued research, health monitoring, animal movement and the prevention of disease, veterinarians have vital roles in the preservation of endangered species. Captive propagation programs provide hope to some of the threatened species alive in a world rife with environmental danger. The sheer scale of the present ecological crisis precludes zoological institutions from becoming "arks" to all endangered species, but through careful selection and design, they can be "lifeboats" for many.

Captive propagation cannot be an end unto itself, but rather an integral part of the larger mosaic that is education, research, and field conservation. All seek preservation. To prevent losses of animal species should be the ultimate goal in animal welfare, for the species involved and for ourselves.

Appendix

Species presently included in species survival plans of the American Association of Zoological Parks and Aquariums

Mammals

addax *(Addax nasoma culatus)*
African elephant *(Loxodonta africana)*
Arabian oryx *(Oryx leucoryx)*
Asian elephant *(Elephas maximus)*
Asian lion *(Panthera leo persica)*
Asian small-clawed otter *(Aonyx cinerea)*
Asian wild horse *(Equus przewalskii)*
Baird's tapir *(Tapiris bairdii)*
barasingha deer *(Cervus duvauceli)*
black-footed ferret *(Mustela nigripes)*
black lemur *(Lemur macaco)*
black rhinoceros *(Diceros bicornis)*
bonobo (pigmy chimpanzee—*Pan paniscus*)
Chacoan peccary *(Tayassu wagneri)*
cheetah *(Acinonyx jubatus)*
chimpanzee *(Pan troglodytes)*
clouded leopard *(Neofelis nebulosa)*
drill baboon *(Papio leucophaeus)*
gaur *(Bos gaurus)*
gibbons (*Hylobates* sp)
golden lion tamarin *(Leontopithecus rosalia)*
greater one-horned rhinoceros *(Rhinoceros unicornis)*
Grevys' zebra *(Equus grevyi)*
lion-tailed macaque *(Macaca silenus)*
lowland gorilla *(Gorilla gorilla)*
lowland tapir *(Tapiris terrestrus)*
Malayan tapir *(Tapiris indicus)*
maned wolf *(Chrysosyon brachyurus)*
okapi *(Okapia johnstoni)*
orangutan *(Pongo pygmaeus)*
red panda *(Ailurus fulgens)*
red wolf *(Canis rufus)*
ruffed lemurs *(Lemur variegatus)*
scimitar-horned oryx *(Oryx tao)*
snow leopard *(Panthera uncia)*
spectacled bear *(Tremarctos ornatus)*
Sumatran rhinoceros *(Didermocerus sumatrensis)*
tiger (*Panthera tigris* sp)
white rhinoceros *(Ceratotherium simum)*

Birds

Andean condor *(Vultur gryphus)*
Bali mynah *(Leucospar rothschildi)*
California condor *(Gymnogyps californianus)*
Guam rail *(Rallus owentoni)*
hooded crane *(Grus monacha)*
Humboldt penguin *(Spheniscus humboldti)*
Micronesian kingfisher *(Halcyon c cinnamomina)*
palm cockatoo *(Probosciger atterimus)*
red-crowned crane *(Grus japonensis)*
St. Vincent parrot *(Amazonia guildingii)*
thick-billed parrot *(Rhynchopsitta p pachyrhyncha)*
wattled crane *(Bugeranus carunculatus)*
white-naped crane *(Grus vipio)*

Reptiles and Amphibians

Aruba Island rattlesnake *(Crotalus unicolor)*
Chinese alligator *(Alligator sinensis)*
Dumeril's ground boa *(Acrantophis dumerili)*
Puerto Rican crested toad *(Peltophryne lemur)*
radiated tortoise *(Geochelone radiata)*
Virgin Island boa *(Epicrates monensis)*

Fish

Lake Victoria cichlids (*Haplochromus* sp and others)

INVERTEBRATES

Partula snails (*Partula* sp)

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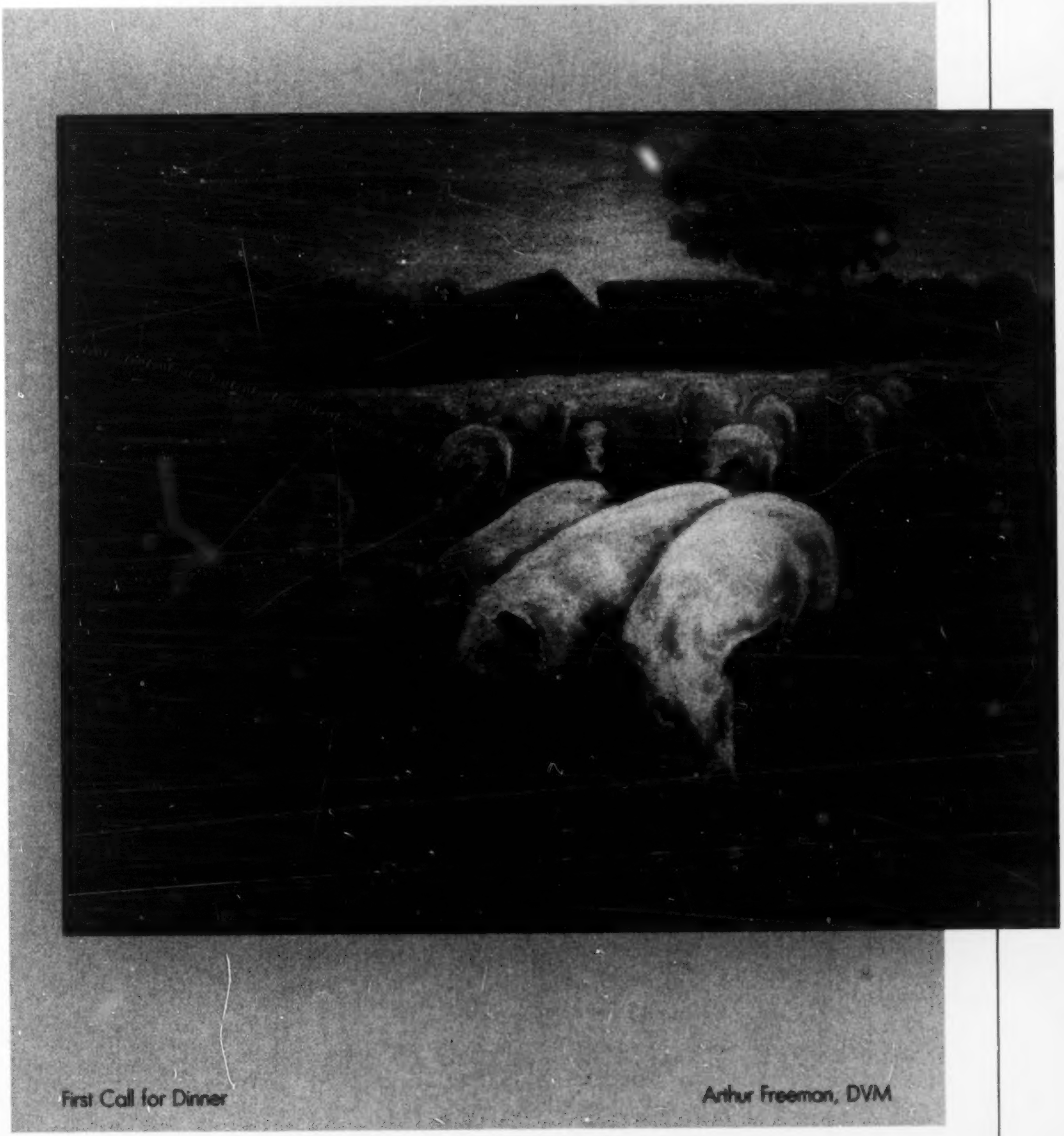
A3100-2

March 15, 1992, Volume 200, Number 6

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION



First Call for Dinner

Arthur Freeman, DVM

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 200 March 15, 1992 No. 6
JAVMA 200 (6) 753-872 (1992)
ISSN 0003-1488

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About the cover

Dr. Arthur Freeman was born in Youngstown, Ohio, and received his DVM at Ohio State University in 1955. Four years later, he accepted a position as assistant editor at the American Veterinary Medical Association where, in 1972, he was appointed editor-in-chief; it was originally Dr. Freeman's idea to use artwork featuring animals on the covers of the *JAVMA*. From 1985 to his retirement in 1989, he served as executive vice president of the AVMA. Dr. Freeman now resides in Carmel, Ind.

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SUBSCRIPTIONS: For one year: members $50; others $100 in the United States and possessions; $120 in foreign countries. Single copies: $6.00 in the United States and possessions; $8.00 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

ADDRESS CHANGE: Send new address (and moving date) 45 days ahead. Include old address as it appeared on previous issues (if possible send label).

POSTMASTER: Send address changes to JAVMA, 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360.

Prevalence of antibody to caprine arthritis-encephalitis virus in goats in the United States

Randall C. Cutlip, DVM, PhD; Howard D. Lehmkuhl, PhD; Jerome M. Sacks, PhD;
Amy L. Weaver, MS

Summary: *Goats from 28 states were tested for antibodies to caprine arthritis-encephalitis virus. Of 3,790 goats, 1,175 (31%) tested positive, and of 196 herds tested, 143 (73%) had 1 or more seropositive members. This prevalence, based on serum samples from all goats in the participating herds, was lower than most rates reported in other studies. Such studies were based on fewer samples, incomplete sampling of herds, or smaller geographic base. Prevalence was highest in western Pacific and northern plains regions, increased with age to 3 years, was highest among goats on family-owned farms, and was lowest in the Angora breed. Differences in prevalence were not related to gender or size of herd.*

Caprine arthritis-encephalitis (CAE) is a multisystemic disease of goats, caused by a lentivirus. The disease is most commonly recognized as chronic lymphocytic and degenerative polyarthritis, interstitial mastitis, or chronic encephalomyelitis of adult goats, but occasionally is seen as acute lymphocytic leukoencephalomyelitis of neonatal goats.[1-5] Many infected goats do not manifest clinical signs of disease, but are persistently infected and are positive for specific antibody.

Two serologic studies of the prevalence of CAE viral infection in goats in the United States have been reported.[4,6] A study of 1,160 goats from 24 states indicated prevalence of 81%.[4] However, results were considered biased because 836 of the 1,160 samples were submitted for diagnostic purposes from herds with clinical evidence of arthritis.[7] The other 324 samples were from 19 herds in Washington and Idaho. A study of goats from 13 dairies in California indicated prevalence of 53% in 2,826 goats, with range of 39 to 80% among herds.[6] Some of these goats were involved in a program for eradication of the CAE virus.

The objective of the study reported here was to test 3,790 goats from 28 states for antibodies to CAE virus. Our objective was to expand over previous studies the number and distribution of goats tested to obtain a more comprehensive estimate of the prevalence of CAE virus infection in the United States.

Materials and Methods

Blood samples were collected from 196 herds of goats in 28 states. From 1982 to 1988, samples were collected by the owners or local veterinarians from 3,790 goats aged 4 months through 15 years. In most instances, the entire herd was tested. Herds were selected because of the interest of owners in a pilot field eradication study. At the time of blood sample collection, the goats were not involved in an organized control program although they were being selectively culled by the owner. Comparisons were made among regions, states, age, gender, breed, and owner type.

States were grouped into 6 regions: northern Atlantic, comprising Connecticut, Maine, New Jersey, New York, Vermont, and West Virginia; northern plains, comprising Iowa, Illinois, Indiana, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, and Wisconsin; Rocky Mountain, comprising Colorado, Montana, and Wyoming; southern Atlantic, comprising Arkansas, Georgia, Louisiana, North Carolina, and Tennessee; southern plains, with the single state of Arizona; and western Pacific, including Oregon and Washington. Only states with at least 5 goat herds were compared individually.

Serum samples were tested for precipitating antibodies to CAE virus, using an agar gel immunodiffusion test described for detection of ovine progressive pneumonia virus.[8] Minor alterations in the procedure consisted of using 7 ml of 0.8% agarose containing 0.4% polyethylene glycol (MW 6,000) rather than 6 ml of 1% agarose without polyethylene glycol as originally reported. Antigen was the ovine progressive pneumonia virus isolate WLC-1 prepared as described.[8] Antigenic cross-reactivity has been documented between the glycoprotein and the internal proteins of ovine progressive pneumonia and CAE viruses[9] (unpublished

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From the National Animal Disease Center, Agricultural Research Service, United States Department of Agriculture, PO Box 70, Ames, IA 50010 (Cutlip, Lehmkuhl, Sacks) and the Department of Statistics, Iowa State University, Ames, IA 50011 (Weaver).

The authors thank Dr. Joan Bowen and Keith Sherman for technical assistance.

Table 1—Prevalence of goats with antibody to caprine arthritis-encephalitis (CAE) virus among regions, states, ownertypes, and herd size

Group	Proportion of goats seropositive (%)	No. of goats tested	Proportion* of herds seropositive (%)	No. of herds tested	Mean† group size
Region‡					
Northern Atlantic	24	654	78	18	36
Northern plains	41	1,210	68	81	15
Rocky Mountains	25	1,077	78	64	17
Southern Atlantic	22	659	63	16	41
Western Pacific	49	87	00	10	9
State§					
Arkansas	44	216	80	5	43
Arizona	49	103	71	7	15
Colorado	28	703	76	55	13
Iowa	45	261	78	18	15
Illinois	48	62	100	6	10
Kansas	36	140	60	5	28
Michigan	4	48	17	6	8
Minnesota	49	254	88	8	32
Missouri	44	70	100	5	14
Montana	21	322	88	8	40
North Carolina	54	24	50	6	4
Nebraska	21	152	63	8	19
New York	34	236	71	7	34
Ohio	29	98	67	12	8
Oregon	68	19	100	5	4
Washington	44	68	100	5	14
Wisconsin	74	102	50	10	10
Other‖	15	912	70	20	46
Owner type					
Farm family	36	2,812	73	190	15
Private institution	12	472	75	4	118
Public institution	19	513	100	2	257
Herd size					
1 to 10	33	488	57	115	4
11 to 50	35	1,344	95	66	20
> 51	27	1,958	100	15	131
All	31	3,790	73	196	19

*Herds with at least 1 seropositive goat. †Mean number of goats in each category within different groups. ‡Southern Plains Region omitted because only Arizona was represented. §States with 5 or more herds tested. ‖States with less than 5 herds tested: Connecticut, Georgia, Indiana, Louisiana, Maine, New Jersey, Pennsylvania, Tennessee, Vermont, West Virginia and Wyoming.

observations). Test results were read as positive only when complete lines of identity were formed with a known positive serum. Only 13% of the sera produced incomplete lines and were considered negative for the purpose of this study. When some such goats were tested 1 or more years later, 49% had positive results and 22% continued to have suspicious results. Results were analyzed as percentage of seropositive goats and as percentage of herds with seropositive members. Prevalence rates for breeds and their herdmates were computed for herds with more than 1 breed.[10,11] Herdmate comparisons were also used for other categories as needed.

Results

Prevalence of goats with antibody to CAE virus varied among regions and among states, but association with herd size was not apparent (Table 1). Among individual herds, seropositivity ranged from 0 to 100%. Size of herds with all seropositive goats ranged from 1 to 56, and that of herds with no seropositive goats ranged from 1 to 17. Prevalence of goats with specific antibody among family-owned farm herds was about twice the rate of public or private institutional herds (Table 1). This difference was observed in all age groups from 0 to 6 years. Mean ± SD difference was 21 ± 6% (*t* test; $P < 0.01$).

Age, gender, or breed identification was missing for approximately 30% of the goat records, but prevalence of goats in the unknown age, gender, or breed categories (Table 2) did not differ greatly from the overall mean of 31%. Prevalence of goats with antibody to CAE virus increased with age (Table 2). Mean increase, approximately 14%/yr, based on a linear regression analysis, was statistically significant ($R^2 = 74\%$; $P < 0.01$). Average herd size decreased by approximately 22%/yr, based on linear regression analysis ($R^2 = 96\%$; $P < 0.01$). Females and sexually intact males had almost identical average prevalence and age specific rate patterns. In wethers, prevalence was less than half that in sexually intact males, but compared with herdmates, the difference was only 11 ± 8% and was not statistically significant. Prevalence among breeds of goats with specific antibody was similar, except for the 9 herds of Angora that had approximately a third the average prevalence. Computation of herdmate differences confirmed low prevalence in the Angora breed, (*t* test; $P < 0.01$; Table 3).

Prevalence of goats with antibody to CAE virus was computed for each herd, and herds were clas-

Table 2—Prevalence of goats with antibody to CAE virus among age groups, genders, and breeds

Group	Proportion of goats seropositive (%)	No. of goats tested	Proportion* of herds seropositive (%)	No. of herds tested	Mean† group size
Age (years)					
<1	18	610	47	75	8
1	28	838	63	116	7
2	34	525	74	91	6
3	45	281	66	77	4
4	41	217	75	60	4
5	48	115	67	39	3
≥6	43	182	65	84	2
Gender					
Female	33	2,463	81	146	17
Male	34	232	58	77	3
Wether	14	191	33	24	8
Unknown	27	904	51	69	13
Breed					
Alpine	39	473	69	42	11
Angora	11	28	22	9	3
LaMancha	39	87	67	9	10
Nubian	32	823	72	81	10
Oberhasli	25	172	100	3	57
Pygmy	37	19	50	6	3
Saanen	37	378	67	30	13
Toggenburg	33	322	72	29	11
Crosses	22	322	55	49	7
Unknown	27	1,166	60	91	13

*Herds with at least 1 seropositive goat. †Mean number of goats in each category.

Table 3—Prevalence of antibody to CAE virus among goat breeds and among members of herds comprising more than 1 breed

Breed	No. of herds tested	Proportion of breed seropositive (%)	Proportion of herdmember seropositive (%)	Herdmember difference (SEM; %)
Alpine	34	39	37	02 (04)
Angora	9	7	37	−30* (07)
LaMancha	8	25	29	−04 (09)
Nubian	52	31	24	07 (04)
Oberhasli	2	57	71	−14 (72)
Pygmy	4	23	23	0 (18)
Saanen	25	28	36	−08 (06)
Toggenburg	25	46	35	11 (07)
Crosses	44	28	31	−03 (05)

*Herdmember difference is significant ($P < 0.05$).

Table 4—Distribution of female and male goats in herds of low, medium, and high seroprevalence to CAE virus

Relative prevalence	No. of herds	Proportion seropositive (%)	Average herd size
Females			
Low*	85	6	20
Medium†	31	32	15
High‡	78	69	15
Male			
Low*	36	2	3
Medium†	18	42	4
High‡	23	87	3

*Herd prevalence > 0.5 SD below group mean. †Herd prevalence within 0.5 SD of group mean. ‡Herd prevalence > 0.5 SD above group mean.

sified as low, medium, or high prevalence if values were at least 0.5 SD below the mean, within 0.5 SD of the mean, or at least 0.5 SD above the mean, respectively (Table 4). This procedure, which should classify the herds into 3 approximately equal groups (31, 38, and 31%) on the basis of a normal distribution, revealed obvious clustering. For either gender, most of the herds were the high or low prevalence groups. The medium prevalence group had the fewest numbers of herds.

Discussion

In this serologic study of the prevalence of antibody to CAE virus in goats in the United States, we have documented the overall prevalence to be about half that previously reported.[4,6,7] This difference probably relates to our testing of younger goats, all goats in most herds, more clinically normal goats, and a wider distribution of goats. Our finding of 49% prevalence in the western Pacific region closely parallels the 53% prevalence reported in goats in California.[6] Prevalence of seropositive goats among states was within a factor of 2 except for Indiana and Michigan, which had the lowest prevalence, and for Oregon and Wisconsin, which had the highest prevalence. The high prevalence rate (74%) in Wisconsin was attributable mostly to 1 herd of 56 goats in which 100% of the members were seropositive. The remaining 9 herds of 46 goats had 41% seropositivity. Prevalence in the western and middle parts of the country was about twice that in the eastern and Rocky Mountain areas of the country. As reported in previous studies, prevalence increased with age; however, in our study, leveling-off was evident after 3 years of age. The reason prevalence increased with age is not known, but may have resulted from lateral transmission of virus between adults or from delayed seroconversion after virus was transmitted to neonates. The plateauing of seroprevalence at 3 years of age may be the result of the owner culling clinically affected goats. The 2 to 3 times higher prevalence in family-owned farm herds than in other owner types may be related to greater movement of goats among family farm owners, as well as other management practices. Differences in prevalence among breeds was not significant except for the lower prevalence in the Angora breed. Lower prevalence in the Angora breed was reported from Australia.[12] To our knowledge, prevalence in Pygmy goats has not previously been reported, but in this study, paralleled that seen in most other breeds.

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Book Review: A Concise Survey of Animal Behavior

This book is a short overview of animal behavior, with a focus on acquainting the reader with the basic fundamentals of ethology. The authors use the first chapter to review the history of the study of animal behavior from Greek philosophy to the work of early 20th century scientists. The second chapter outlines the concepts used by ethologists: behavior as adaptation to an environment, evolution as it may explain the appearance of a particular behavior, mechanisms controlling the initiation of behavior, and how a behavior develops and changes. The next chapter addresses some common ethologic research areas. These include: biological rhythms, migration, hormonal control of behavior, and social behavior. Brief discussions are also included regarding the issues of animal reasoning, animal rights, and human–animal interactions. The final chapter gives the reader an ethologist's view of the most important aspects of normal behavior for domestic ruminants, nonruminants, carnivores, birds, and exotic pets. A supplemental reading list is provided at the end of the book referencing a number of *Scientific American* articles of historical interest.—[*A Concise Survey of Animal Behavior. By E.K. Honore and P.H. Klopfer. 186 pages; illustrated. Academic Press Inc, 1250 Sixth Ave, San Diego, CA 92101. 1991. Price $29.95*]—WALTER F. BURGHARDT, JR.

Prevalence, type, and importance of splenic diseases in dogs: 1,480 cases (1985-1989)

W. L. Spangler, DVM, PhD, and M. R. Culbertson, DVM, PhD

Summary: *The prevalence data of splenic diseases from 3 sources were studied. Group 1 consisted of a general diagnostic survey of accessions submitted from private veterinary hospitals in California during a period of approximately 4 years and included 1,372 submissions of canine splenic tissue. Group 2 consisted of surgical splenectomy specimens from 92 dogs; the specimens were submitted to the laboratory for gross and histologic evaluation prior to fixation, and a questionnaire was subsequently sent to determine the outcome of the disease. Group 3 was made up of specimens of 105 splenic lesions derived from a large colony of Beagles with complete medical records and records of pathologic findings.*

In this study, splenic hematoma and hyperplastic nodule, not hemangiosarcoma, made up the bulk of splenic lesions. Hemangiosarcoma was the most frequent neoplasm of the canine spleen, but the combined prevalence of all other splenic neoplasms was similar to that of hemangiosarcoma alone. Splenic hematoma and hemangiosarcoma were grossly indistinguishable in most cases. Hyperplastic lymphoid nodules and hematomas of the spleen appeared to represent a continuum. If that finding was correlated with microscopic splenic blood flow, specific causal relationship could be suggested. Prognostically, the live/dead ratio and mean survival of dogs with various splenic lesions differed significantly.

Most clinical reports that specifically consider the canine spleen are concerned with some aspect of neoplasia, and often more specifically, with hemangiosarcoma.[1-5] In a report including hemangiosarcomas in all tissues, the prevalence of canine hemangiosarcoma varied between 0.3 and 1.98%. Among hemangiosarcomas reported, 62% originated in the spleen. This perspective of splenic disease in dogs tends to distort the importance of neoplasia in the canine spleen relative to the prevalence and importance of nonneoplastic splenic diseases.[3,5] Although actual prevalence data concerning specific primary splenic diseases are scant, some publications emphasize hyperplastic (nodular lymphoid hyperplasia) and degenerative (splenic hematoma) lesions.[3,5,6] The purpose of the study reported here was to determine the prevalence of specific splenic diseases in dogs, as well as possible pathogenetic mechanisms for the formation of splenic hematoma.

Criteria for Selection of Cases

The dogs in this study were allotted to 3 groups. Records of group-1 dogs were derived from retrospective review of computerized pathologic records from a private diagnostic laboratory.[a] The records were searched for diagnoses that included spleen or splenic as part of the diagnostic terminology. A total of 1,372 cases in dogs were retrieved from a period of 50 months (July 1985 to September 1989). These cases represented 1.3% of approximately 124,000 total accessions from all species of animals during that period. The selected cases represented canine surgical/necropsy specimens submitted from veterinary practices distributed throughout California. Representative sections from all fixed materials were selected from individual submissions and prepared for microscopic evaluation. Group-2 dogs consisted of 92 dogs, for which unfixed spleens derived from surgical splenectomy, were submitted to the laboratory for gross and histologic evaluation (follow-up subgroup). Although the specimens from those dogs were part of the spleens considered in group 1, these tissues were examined grossly by one of the authors (WLS), described, measured, and sampled at multiple (minimum of 7) sites from 0.5- to 1-cm serial gross sections obtained from the fresh tissue. Photographs were obtained in many cases. Microscopic evaluation of these specimens was followed by a letter to the submitting veterinarian requesting the specific health status of the animal and any omitted information (eg, age, gender, breed) to

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From the California Veterinary Diagnostics Inc, 3911 W Capitol Ave, West Sacramento, CA 95691.

Supported in part by the Office of Health and Environmental Research, US Department of Energy center contract DE-AC03-76SF00472 and under grant DE-FG03-89ER60914/92 with the University of California, Davis.

[a] California Veterinary Diagnostics Inc, West Sacramento, Calif.

Table 1—Prevalence of canine splenic lesions by specific diagnosis (group 1)*

Lesion	No.	Percentage
Hyperplastic nodule	306	23
Hemangiosarcoma	137	10
Hematoma	129	10
Hyperplastic nodule/ hematoma	128	10
Accessory spleen	46	3
Siderotic plaque	38	3
Lymphosarcoma	38	3
Diffuse lymphoid hyperplasia	22	2
Leiomyosarcoma	23	2
Undifferentiated sarcoma	23	2
Mixed lymphoid myeloid hyperplasia	17	1
Myeloproliferative disease	17	1
Myeloid metaplasia	15	1
Splenic infarction	14	1
Splenic arterial thrombosis	12	<1
Metastatic carcinoma	11	<1
Myelolipoma	8	<1
Splenic torsion	8	<1
Fibrosarcoma	7	<1
Mast cell tumor	6	<1
Splenitis	6	<1
Metastatic adenocarcinoma	5	<1
Myeloid hyperplasia	5	<1
Plasma cell myeloma	4	<1
Splenic abscess	4	<1
Reticuloendothelial hyperplasia	4	<1
Amyloidosis	3	<1
Multidifferentiated sarcoma (mesenchymoma)	3	<1
Myxosarcoma	2	<1
Hemangioma	2	<1
Osteosarcoma	1	<1
Sinusoidal telangiectasis	2	<1
Necrosis/hemorrhage	2	<1
Splenic fibrosis	2	<1
Capsulitis	2	<1
Capsular mineralization	1	<1
Traumatic rupture	1	<1
Histiocytosis	1	<1
Extramedullary hematopoiesis†	84	6
Congestion†	97	7
Lymphoid atrophy/depletion†	49	4
Hemosiderosis†	20	2
Lymphoid necrosis†	17	1
Splenic necrosis†	4	<1

*Forty-six submissions characterized histologically as normal spleen are excluded from this table. †Represents the diagnosis in the spleen derived from cases in which multiple tissues were submitted for evaluation.

*Table 2—Prevalence of canine splenic lesions by specific diagnosis (group 2)**

Lesion	No.	Percentage
Hemangiosarcoma	22	24
Hyperplastic nodule/hematoma	18	19
Hematoma	18	19
Hyperplastic nodule	6	6
Myeloid metaplasia	5	5
Leiomyosarcoma	4	4
Multidifferentiated sarcoma (mesenchymoma)	4	4
Histiocytic sarcoma	3	3
Lymphosarcoma	3	3
Hemangioma	2	2
Splenic infarction	2	2
Congestion	2	2
Splenic vascular thrombosis	1	1
Fibrosarcoma	1	1
Plasma cell myeloma	1	1
Myxosarcoma	1	1

*Ninety-two individual submissions, 93 diagnoses.

Table 3—Prevalence of splenic disease in Beagles (group 3)*

Lesion	Total	Percentage
Hyperplastic nodule	52	48
Diffuse lymphoreticular hyperplasia	12	11
Hemangiosarcoma	10	9
Lymphosarcoma	7	6
Hyperplastic nodule/hematoma	6	6
Metastatic neoplasia	6	6
Undifferentiated sarcoma	4	4
Myeloid metaplasia	5	4
Lipoma	2	2
Leiomyosarcoma	2	2
Hemangioma	2	2

*Three hundred seventy-four dogs at risk.

statistically evaluate clinical prognostic factors in canine splenic disease. In group-3 dogs, the surgical and necropsy records from a colony of Beagles were reviewed for similar purposes. These dogs were subject animals in a life-time study of chronic exposure to ^{90}strontium or ^{226}radium. In that study,[7] animals were exposed to various doses of radionuclides with various routes of administration and were monitored for life by periodic clinical and radiographic examination as well as by a variety of clinical analytical methods as required by the protocol. Complete necropsy was performed on all (865) dogs. The data concerning splenic diseases in 105 of the dogs were derived from retrospective analysis of the slides and records of pathologic findings, which for the most part were originally generated by the authors.

Information derived from these 3 data sources was tabulated separately. Each of the splenic lesions (diagnoses) was reviewed histologically. The resulting information was then manually entered into a flat data computer file capable of segregating, grouping, and ordering the data for subsequent analysis. The duration of postoperative survival in the group-2 dogs was compared statistically by use of the Mann-Whitney method. Gender proportions were tested by use of the χ^2 method.

Results

Hyperplastic nodules and splenic hematoma were the most often encountered disease conditions among the canine spleens from all 3 data sources considered by this study. Splenic hemangiosarcoma was second in overall prevalence. In our data, the ratio of nonneoplastic to neoplastic disease in the canine spleen (the general diagnostic population) was 3.6:1 (1,039 to 287) in group 1 (Table 1), 1.3:1 (52 to 41) in group 2 (the follow-up subgroup; Table 2), and 2.3:1 (75 to 33) in group 3 (Beagles; Table 3). Splenomegaly resulted from nonneoplastic diseases in 56% of diagnoses (52 of 93) and from splenic neoplastic diseases in 44% (41 of 93) of diagnoses in group 2. Also in group 2, splenomegaly resulting from hyperplastic nodule and hematoma formation accounted for 42 cases (46% of splenic submissions), whereas splenomegaly and splenectomy attribut-

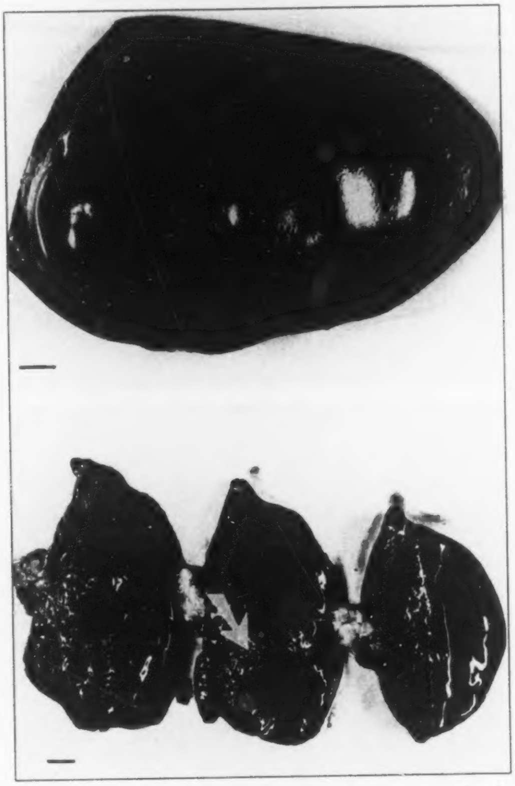

Figure 1—A 10.5-cm subcapsular splenic hematoma (top). Cross sections of a subcapsular hematoma demonstrating a histologically confirmed underlying focus of nodular lymphoid hyperplasia (arrow; bottom). Bar = 1 cm.

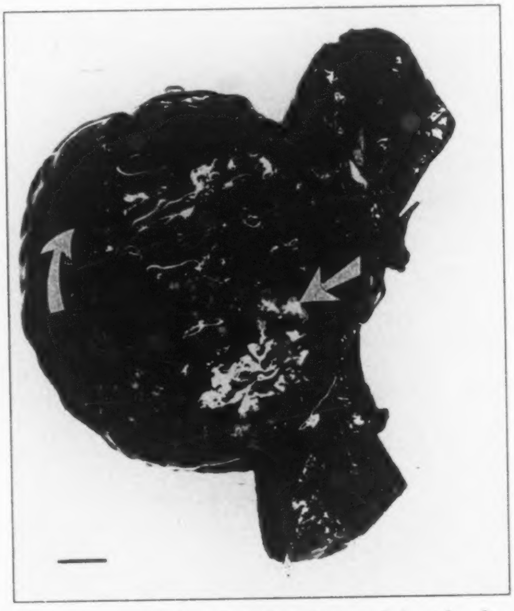

Figure 2—Sectioned surface of a splenic nodule with a discrete area of nodular lymphoid hyperplasia (histologically confirmed; straight arrow) underlying an organizing hematoma (curved arrow); bar = 1 cm.

able to hemangiosarcoma accounted for 22 cases (24% of splenic submissions).

Hyperplastic lymphoid nodules were observed in many specimens in association with splenic hematoma. Macroscopic and microscopic examinations revealed disorganized or compressed lymphoid hyperplastic, or mixed lymphoid-hematopoietic foci along the margins of a splenic nodule consisting of hemorrhage, organizing fibrin, or degenerating erythrocytes (Fig 1 and 2). Similarly, hemorrhagic areas were found within some nodular lymphoid or hematopoietic foci (Fig 3). In some specimens, only erythrocytes or the sequelae of prior hemorrhage (organizing clot) could be detected microscopically (splenic hematoma).

There was no typical gross appearance to reliably distinguish splenic hematoma from hemangiosarcoma and most generally, pathologic features were similar. However, primary hemangiosarcoma of the spleen tended to be multifocal, nodules were individually smaller than hematomas, and most were cavitated with a honeycomb appearance on the sectioned surface. Many of the cavities in hemangiosarcoma contained unclotted blood and resulted in spherical nodules of various sizes, many of which were dimpled or collapsed with a slack or wrinkled overlying splenic capsule, indicating a lack of underlying structural integrity. In contrast, the clotting of blood and subsequent organization tended to give splenic hematomas a firm consistency, producing a nodule that smoothly and firmly distorted the surface of the spleen and one, which on the cut surface, appeared to be compartmentalized or geometrically divided into compartments of various sizes with straight sides or walls made up of connective tissue and with brown discolored irregular areas of necrosis and tissue liquefaction.

The German Shepherd Dog breed ranked first in breed prevalence among the splenic diseases in the categories of hyperplastic nodule/hematoma, hemangiosarcoma, and lymphosarcoma. Golden Retrievers and Labrador Retrievers ranked second and third, respectively, in those categories. An attempt was not made to correct these data for actual breed prevalence in this area. Hyperplastic nodule/hematoma and hemangiosarcoma were found at virtually the same mean age in dogs (10.5 and 10.4 years, respectively) and were evenly distributed between the genders. In group 2, the mean age of dogs with splenic lymphosarcoma was 9.4 years, but the diagnosis of accessory spleen was made at 6.8 years. Myeloid metaplasia/hyperplasia was found in dogs with a mean age of 8.7 years and was found 5 times more often in females than males ($\chi^2 = 6.24$; $P < 0.025$).

Foci of accessory or ectopic splenic tissue represented 3% of splenic lesions submitted to the laboratory (Table 1). These aggregates of viable and identifiable splenic tissue were of various sizes, remote from the spleen, and most were implanted in or attached to the omentum.

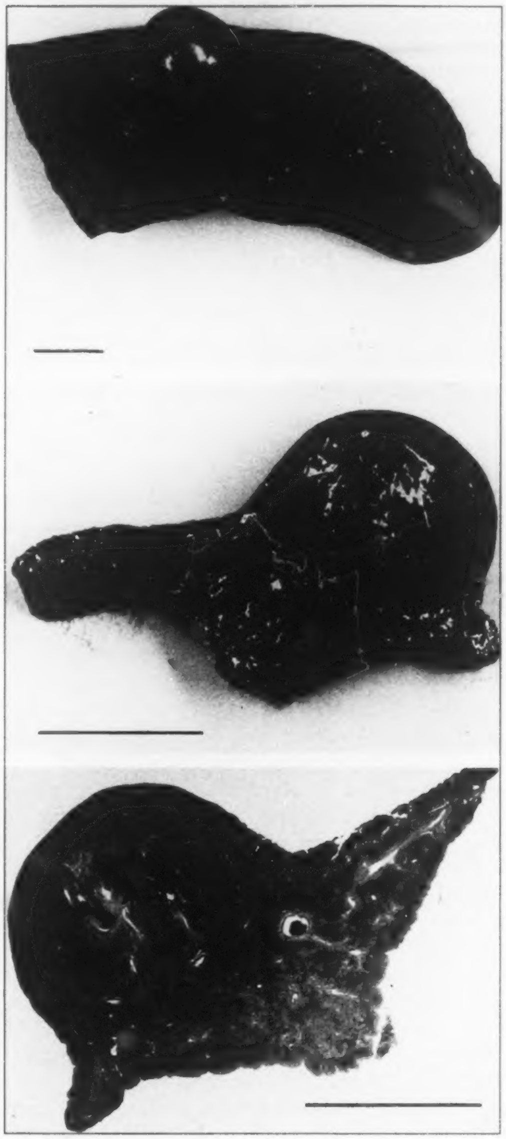

Figure 3—A 1.5-cm single black nodular mass protruding from the parietal surface of the spleen (top). Sectioned surface of splenic nodule in top photograph. The sectioned surface is homogeneous with no distinguishing features (middle). Photomacrograph of section of spleen of a dog. Notice nodular hyperplasia of splenic lymphoid elements with widely dispersed hemorrhages (arrows; bottom). H&E *stain; bar = 1 cm.*

Myeloid metaplasia/hyperplasia was found as a cause of diffuse, nonnodular splenomegaly in dogs and was characterized by diffuse proliferation of hematopoietic elements at the expense of normal lymphoid follicular and sinusoidal architecture. This proliferation was diffuse throughout the splenic parenchyma, with no organization as discrete hematopoietic foci such as that observed in cases of splenic extramedullary hematopoiesis responding to severe anemia.

Neoplastic disorders of the canine spleen were dominated by hemangiosarcoma in all groups. Hemangiosarcoma accounted for 48% (137 of 287) of all splenic neoplasia in group 1, whereas lymphosarcoma constituted 13% (38 of 287) of the diagnoses in the neoplastic category (Table 1). The remaining 39% (112 of 287) of neoplasms was divided among 13 distinct histologic types.

Definitive survival information was obtained for all but one of the 92 cases in the follow-up survey (group 2). When live/dead ratios were calculated with mean survival times for all neoplastic splenic diseases, 68% of the dogs (28 of 41) were dead at the time of follow-up, and the mean survival was 3.13 months ($n = 39$). For all nonneoplastic splenic diseases, only 41% (21 of 51) of the dogs were dead at the time of follow-up, and the mean survival was 7.06 months ($n = 51$). More specific analysis revealed that 82% of dogs with a diagnosis of splenic hemangiosarcoma (18 of 22) were dead at the time of the follow-up (mean survival = 3.02 months), whereas only 37% of dogs with a diagnosis of hyperplastic nodule, hematoma, or both (16 of 41) were dead (mean survival = 7.55 months; $P < 0.001$). These data included all those dogs that died in the immediate postoperative period (0 months survival time). Results for nonangiogenic and nonlymphomatous sarcomas of the spleen were divergent. Although dogs with a diagnosis of splenic fibrosarcoma (1 of 92), leiomyosarcoma (4 of 92), histiocytic sarcoma (3 of 92), and splenic osteosarcoma (1 of 92) were all dead at the time of follow-up (mean survival = 2 months), those dogs with multidifferentiated sarcoma/mesenchymoma (5 of 92) were alive 7.33 months after surgery.

Discussion

Because the spleen is accessible through palpation and radiographic, cytologic, and surgical procedures and because of the high prevalence of splenomegaly detected in this study, we would rank examination of the spleen as an important overall consideration in the practice of veterinary medicine in dogs.

The prevailing perception among veterinarians is that hemangiosarcoma is the most prevalent form of canine splenic disease.[1-4] However, on the basis of more recent surveys,[5,6] and our findings, this perception of splenic disease may require reevaluation. It is only recently that the term hematoma has been used in reference to discrete splenic lesions.[5,6] On the other hand, nodular hyperplasia of lymphoid components is a recognized and frequently encountered lesion in the spleen of aging dogs.[8-10] Although the recognition that hemorrhage may occur in these areas of splenic nodular hyperplasia can be cited, it is anecdotal and not substantiated by numeric or anatomic data.[9,10] The complete pathologic evaluation of large numbers of spleens (group 2) in this report, in which nodular hyperplastic lymphoid elements were observed with superimposed hematomas, represents convincing anatomic evidence that splenic hyperplastic nodules and splenic hematomas in dogs are related. This association is more strongly supported when the circulatory pattern through the canine spleen is considered.[11,12] A portion of the arterial blood arriving in the spleen through the branches of the follicular arteries enters the reticular spaces of the marginal zone surrounding splenic lymphoid follicules. This blood exits the marginal zone by draining via open-ended venous structures into the sinusoids of the red pulp and finally into collecting veins. It is easy to visualize the consequences of marginal zone distortion resulting from nodular lymphoid hyperplasia with regional disruption of splenic blood flow, failure of marginal zone circulation, and accumulation of blood within and around the hyperplastic nodule eventually leading to hematoma formation, hypoxia, and necrosis.

Although splenic hemangiosarcoma (n = 137) was the second most frequent diagnosis, the prevalence of splenomegaly associated with hyperplastic nodule/hematoma (n = 563) was approximately 4 times greater than hemangiosarcoma in the group-1 dogs (Table 1). In the more limited follow-up series of spleens (group 2), hyperplastic nodule/hematoma and hemangiosarcoma accounted for 45% (42 of 93) and 24% (22 of 93) of diagnoses, respectively; a ratio of 2:1 (Table 2). These observations were primarily responsible for initiation of the complete gross and histologic evaluation of splenic submissions in the group-2 dogs of this study and confirm the relationships between nodular enlargement of the spleen and the prevalence of nonneoplastic nodular splenomegaly. The prevalence of type and class of splenic disease varied in this study on the basis of the sampling method. In the case of the larger general diagnostic survey (group 1), all splenic submissions were combined without regard for the basis of the submission. Included in this segment of the population was a substantial number of multiple tissue submissions derived from necropsy on dogs of diverse ages and dying from a variety of infections or unknown specific causes. Also included in the general diagnostic survey were sections of spleens derived from abnormalities observed during exploratory laparotomy. Many of these were lesions lacking primary disease importance, and therefore, dilute the relative prevalence of primary splenomegaly. On the other hand, the follow-up survey (group 2) consisting entirely of splenectomy specimens is, in some ways, a more accurate representation of the prevalance of specific types of splenic diseases resulting in splenectomy in the general canine population. This conclusion is strengthened to some degree because one pathologist was responsible for gross evaluation and tissue selection from all specimens submitted for evaluation. The Beagle population (group 3) represents data from a tightly controlled population of purebred dogs. These data are most like that observed in group-1 dogs. It should be mentioned, however, that Beagles as a specific breed contributed in a minor way to the overall prevalence of splenic disease and total spleen submissions to the laboratory. This may be the result of a small number of Beagles found in the pet population of this geographic area.

Accessory splenic tissue made up 3% of submissions in the group-1 dogs (46 of 1,326). Although accessory spleen was noticed among group-2 dogs, it was not tabulated because the splenectomy specimen was generally accompanied by a variable amount of omentum, much of which was tightly adhered to the surface of nodular formations in the splenic parenchyma. The reason for the presence of accessory splenic tissue in most cases was obscure. Trauma is a reported cause,[8,13] and on the basis of our observations, fragmentation of splenic nodular lesions may be a major contributing factor. In our specimens, we were consistently unable to grossly distinguish between accessory splenic tissue and the omental implantation of hemangiosarcoma.

We could only find the descriptive pathologic features of myeloid metaplasia/hyperplasia as an unreferenced discussion in a standard pathology text.[14] It was an important cause of splenomegaly and splenectomy in all 3 groups in this study and by this inference, is apparently of clinical importance. A case report of a disease syndrome with striking similarities to these dogs was found.[15] Information in the follow-up survey revealed a lack of positive correlation between myeloid metaplasia and neoplastic myeloproliferative disease involving the spleen. In group-2 dogs, 5 cases of splenic myeloid metaplasia were recorded. Three of the 5 dogs were alive at the time of the survey with a mean survival at that point of 7.7 months (range, 4 to 13 months). One of the dogs was dead with a postmortem diagnosis of myeloproliferative disease, and one of the dogs was lost to follow-up. The gender of the animal was reported for only 13 of the 20 cases of myeloid metaplasia/hyperplasia in group-1 dogs; however, among those reporting, female predominance was significant ($P < 0.025$). In contrast to the group-1 dogs (general diagnostic survey), in group 2 (follow-up subgroup), 4 of the 5 dogs were males, effectively reversing the gender predilection observed previously.

The proportion of hemangiosarcoma to nonangiomatous/nonlymphomatous tumors in our study was 2:1 (group 1), 1.2:1 (group 2), and 1.4:1 (group 3), compared with 4:1 in another study.[16] We found a wide variety of sarcomatous lesions among the dogs in the 3 data groups. The combined prevalence of nonangiomatous/nonlymphomatous sarcomas was similar to that of hemangiosarcoma alone, and these tumors constituted a major cause of splenomegaly, splenectomy, and mortality.

On the basis of our findings, splenic disease is an important clinical consideration in dogs. Pathologic evaluation of specimens submitted because of splenomegaly and other clinical indications for splenectomy are likely to reveal a large nonneoplastic nodular spleen with good prognostic characteristics. The finding of small, red, disseminated intraabdominal masses, when associated with a microscopic diagnosis of splenic hemangiosarcoma, is indicative of a grave prognosis. However, similar lesions of no clinical consequence also can be seen with a diagnosis of splenic hematoma. When survival of the dog is correlated with the type of splenic disease (group 2), a distinctive trend is noticed. These data suggested a markedly different prognosis for canine splenic diseases that are surgically and clinically indistinguishable, emphasizing the importance of careful gross evaluation (by a pathologist, if available) and selection of multiple tissue sections from the interface area between splenic nodules and adjacent splenic parenchyma. The general prognosis for dogs with nodular splenomegaly appears to be better than is generally perceived.

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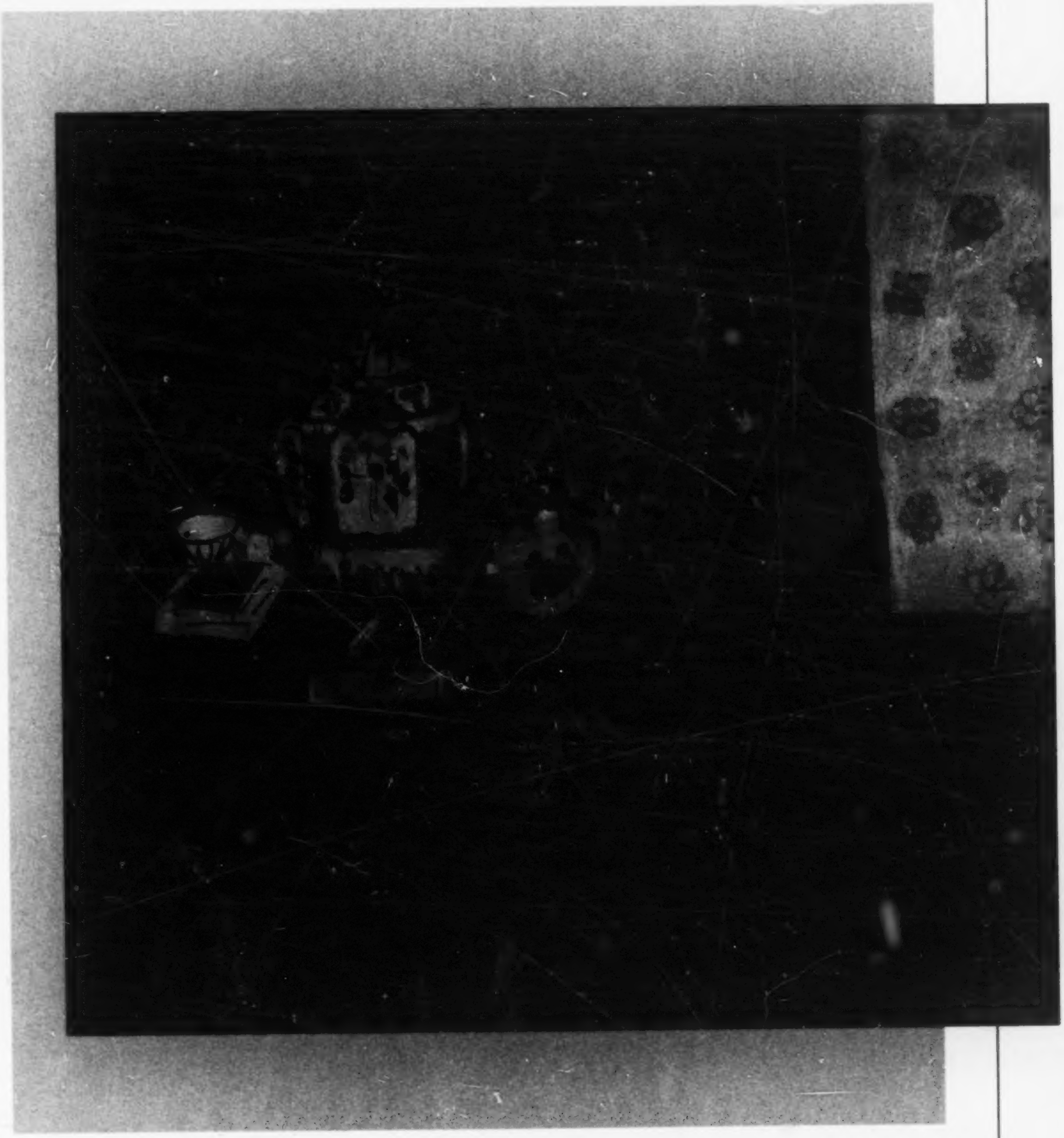
A3100-2

April 1, 1992, Volume 200, Number 7

JOURNAL

OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION



JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 200 April 1, 1992 No. 7
JAVMA 200(7) 873-1048 (1992)
ISSN 0003-1488

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SUBSCRIPTIONS: For one year: members $50; others $100 in the United States and possessions; $120 in foreign countries. Single copies: $6.00 in the United States and possessions; $8.00 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

ADDRESS CHANGE: Send new address (and moving date) 45 days ahead. Include old address as it appeared on previous issues (if possible send label).

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Special Report

Rabies surveillance in the United States during 1990

Iyorlumun J. Uhaa, DVM, PhD; Eric J. Mandel, MS; Ruth Whiteway; Daniel B. Fishbein, MD

Summary: *In 1990, the United States and its territories reported 4,881 cases of rabies in animals to the Centers for Disease Control, a 1.5% increase from 1989. Of these, 553 were domestic animals, 4,327 were wild animals, and one was a human being. Pennsylvania reported the highest number (611) of rabies cases in animals in 1990. For the first time since surveillance of rabies in wild animals was begun in the 1950s, the number of cases of rabies in raccoons exceeded that in skunks. Particularly large increases of cases of rabies in wild and domestic animals were reported in New Jersey (469 cases in 1990 compared with 50 cases in 1989, an increase of 838% from 1989) and New York (242 cases in 1990 compared with 54 cases in 1989, an increase of 348%). The 1,821 cases of rabies in raccoons represented a 17.9% increase over those reported in 1989 and 24.5% over those in 1988. This increase was largely attributable to the larger number of rabid raccoons in New Jersey and New York. Other states that reported an increased number of rabies cases in animals in 1990 included Utah (77.8%), Louisiana (64.7%), North Dakota (60.3%), Arizona (28.6%), Oklahoma (27.5%), Delaware (22.2%), and Maryland (20.6%). Thirty states reported a decrease in the number of cases of rabies in animals.*

Since the 1960s, rabies has been reported more frequently in wild animals than in domestic animals, with rabies in wild animals accounting for 89% of all cases reported to the Centers for Disease Control (CDC) between 1980 and 1989 (Fig 1). The most frequently reported rabid wild animals have been skunks, raccoons, bats, and foxes. Five rabies epizootics are currently recognized in the United States: two attributable primarily to raccoons (southeastern and the mid-Atlantic states), and three attributable to skunks (North and South Central states, and Northern California).[1]

The mid-Atlantic raccoon epizootic originated in the late 1970s by the transport of raccoons incubating rabies from the southeast United States into the mid-Atlantic region.[2] This epizootic has continued to spread northward and westward into all of Virginia, West Virginia, Maryland, Pennsylvania, New Jersey, New York, and most recently into Connecticut and North Carolina (Fig 2).

This report was prepared to update the 1989 report[3] on rabies in animals and to provide information on trends in rabies in the United States, Canada, and Mexico for 1990. Emphasis will be given to the species involved, geographic distribution, and secular trends in epizootics and their relationships to public health.

Collection of data

The method used to collect data was similar to that used by Reid-Sanden et al.[3] Briefly, between Jan 1 and Dec 31, 1990, all 50 states, the District of Columbia, and Puerto Rico reported all laboratory-confirmed cases of rabies in animals to the Centers for Disease Control. Forty-six states submitted data monthly on the number of rabies cases, stratified by county of origin and species. Five states submitted data via the National Electronic Telecommunications System for Surveillance. All diagnoses of rabies in animals were made on the basis of a positive result of the direct fluorescent-antibody test on brain tissue by state health department laboratories. Virus isolation in mice or in neuroblastoma cells were sometimes performed to confirm results of the direct fluorescent-antibody test. All data were verified and confirmed for accuracy with individual state health departments. Data from Canada and Mexico were obtained from the Animal Health Division, Canadian Department of Agriculture, and from the Direccion General de Medicina Preventiva, Secretaria de Salud, Mexico.

Rabies in wild animals

Wild animals continued to account for most

From the Viral and Rickettsial Zoonoses Branch (Uhaa, Fishbein) and Biometrics Unit (Mandel), Division of Viral and Rickettsial Diseases, National Center for Infectious Diseases, Centers for Disease Control, Atlanta, GA 30333. Ms. Whiteway is a fourth year veterinary student at the School of Veterinary Medicine, University of Georgia, Athens, Ga.

The authors thank James G. Dobbins (National Center for Infectious Diseases, Centers for Disease Control) and the state and territorial health and agriculture departments of the United States for their contributions.

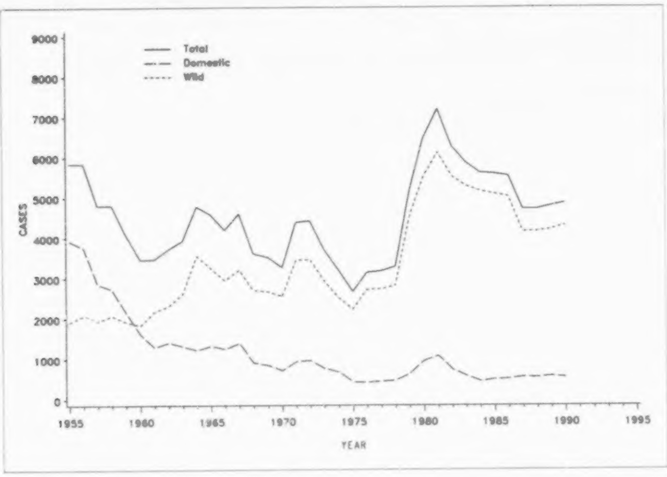

Figure 1—Cases of animal rabies in the United States, by year, 1955 to 1990.

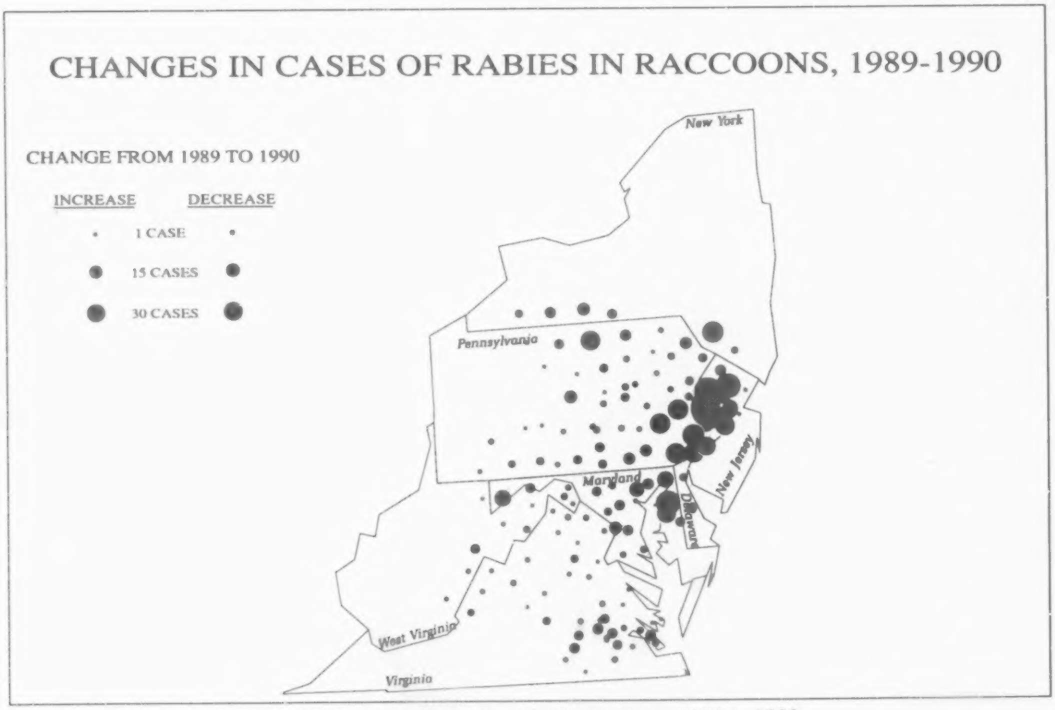
CHANGES IN CASES OF RABIES IN RACCOONS, 1989-1990
CHANGE FROM 1989 TO 1990
INCREASE
DECREASE
1 CASE
15 CASES
30 CASES
New York
Pennsylvania
New Jersey
Maryland
Delaware
West Virginia
Virginia

Figure 2—Changes in cases of rabies in raccoons in the mid-Atlantic states, 1989 to 1990.

(88.6%) reported cases (Fig 1). In 1990, 4,327 cases of rabies in wild animals were reported, a 2.4% increase over the 4,224 cases reported in 1989 (Table 1). The majority of cases (86.8%) were reported from disease reservoirs in raccoons, skunks, foxes, and bats. Only raccoon cases increased in number (1,821 cases), a 17.9% increase from 1989. Raccoon cases exceeded skunk cases for the first time since surveillance of rabid wild animals was initiated in the 1950s (Fig 3). The other three major wild animal reservoirs decreased in number: skunks by 4.7%, foxes by 4.8%, and bats by 12%.

Raccoons—The 1,821 cases of rabies in raccoons reported in 1990 was the largest number of cases reported since 1983, when 1,906 cases were reported. Delaware, Maryland, New Jersey, New York, Pennsylvania, and Virginia reported 1,445 (79.4%) of the total number of raccoon cases, whereas the southeastern states of Alabama, Florida, Georgia, and South Carolina reported 342 cases (18.8%). The distribution of rabies in raccoons in the United States in 1990 shows that urban and suburban areas continue to be intensely affected (Fig 4). The epizootic moved into the state of New York with 84 new cases of rabies in

Table 1—Cases of rabies, by state and category in the United States during 1990

				Domestic animals						Wild animals								
State	All animals	Domestic	Wild	Dogs	Cats	Cattle	Horses/mules	Sheep/goats	Swine	Skunks	Foxes	Bats	Raccoons	Rodents and lagomorphs*	Other wild†	Human being	1989	Percentage change‡
Total	4,881	553	4,327	148	176	173	45	9	2	1,579	197	637	1,821	28	65	1	4,809	1.5
AL	90	16	74	7	9					2	8	8	54	1a	1e		117	-23.1
AK	26	0	26								23				3f		71	-63.4
AZ	36	3	33		3					8		25					28	28.6
AR	39	2	37			1	1			28		9					89	-56.2
CA	361	11	350	3	3	1	2	2		230	10	105			5g		395	-8.5
CO	23	0	23									23					34	-32.4
CT	3	0	3									3					3	0.0
DC	8	0	8										8				12	
DE	44	0	44							5	1		37	1b			36	22.2
FL	99	6	93	2	4					2	5	19	63		4h		190	-47.9
GA	202	16	186	9	4	1	2			20	12	8	143		3i		233	-13.3
HI	0	0	0															
ID	7	0	7									7					11	-36.4
IL	30	2	28			2				17		11					29	3.4
IN	14	1	13				1				1	12					22	-36.4
IO	215	78	137	12	19	35	10	2		122		11	3	1b			203	5.9
KS	45	3	42		1		2			37		5					59	-23.7
KY	56	13	43	9	1	3				35	4	4					134	-58.2
LA	28	0	28							27		1					17	64.7
ME	1	0	1									1					2	-50.0
MD	468	15	453	1	11	2	1 horse			35	17	14	382	4b	1j		388	20.6
MA	10	0	10									10					5	100.0
MI	51	3	48		3					1	1	46					29	75.9
MN	236	53	183	15	11	23	4			164	1	17	1				149	58.4
MS	3	0	3									3					4	-25.0
MO	30	6	24	4		1	1			12		12					62	-51.6
MT	47	4	43			4				27		16					71	-33.8
NE	5	1	4	1						4							33	-84.8
NV	18	1	17			1						17					9	100.0
NH	3	0	3									2	1				2	50.0
NJ	469	10	459		8	1		1		30	1	9	408	9c	2k		50	838.0
NM	14	0	14							7		7					21	-33.3
NY	242	17	225	2	1	14				23	34	84	84				54	348.1
NC	9	0	9							3		6					9	0.0
ND	93	26	67	6	2	17	1			66				1b			58	60.3
OH	10	1	9				1				1	8					14	-28.6
OK	130	18	112	3	10	4	1			107		5					102	27.5
OR	1	0	1									1					6	-83.3
PA	611	47	564		34	8	5			102	29	19	405	8b	1l		702	-13.0
PR	55	22	33	11	5	5		1							33m		84	-34.5
RI	0	0	0														1	-100.0
SC	130	8	122	1	6		1			20	13	4	82		3l		192	-32.3
SD	209	56	153	11	8	31	4		2	145	1	6		1d			125	67.2
TN	58	4	54	4						43	3	6	2				87	-33.3
TX	264	68	195	40	14	6	5	3		117	24	45	2		7n	1	406	-35.0
UT	16	1	15		1							15					9	77.8
VT	0	0	0														1	-100.0
VA	202	16	186	1	11	3	1			42	8	6	129		1l		262	-22.9
WA	4	0	4									4					9	-55.6
WV	40	4	36	1	3					14		5	17				48	-16.7
WI	70	19	51	4	3	10	2			37		12		2b			55	27.3
WY	56	2	54	1	1					47		6			1p		77	-27.3
Percentage‡	100	11.33	88.65	3.03	3.61	3.54	0.92	0.18	0.04	32.35	4.04	13.1	37.31	0.57	1.33	0.02	100	
Total 1989§	4,809	584	4,224	160	212	151	51	8	1	1,657	207	720	1,544	21	75	1		
% change‖	1.5	-5.31	2.44	-7.5	-17	14.57	-11.765	12.5	100	-4.707	-4.83	-12	17.9	33.33	-13.3	0		

*Rodents and lagomorphs include: (a) 1 squirrel; (b) 17 groundhogs; (c) 8 groundhogs, 1 rabbit; (d) 1 shrew. †Other wild includes: (e) 1 opossum; (f) 3 wolves; (g) 2 bobcats, 1 opossum, 2 coyotes; (h) 1 otter, 3 bobcats; (i) 2 coyotes, 1 bobcat; (j) 1 otter; (k) 2 deer; (l) 5 bobcats; (m) 33 mongooses; (n) 3 coyotes, 4 bobcats; (p) 1 coyote. ‡Percentage of all rabid animals in 1990. §1989 total by species. ‖Percentage change from 1989.

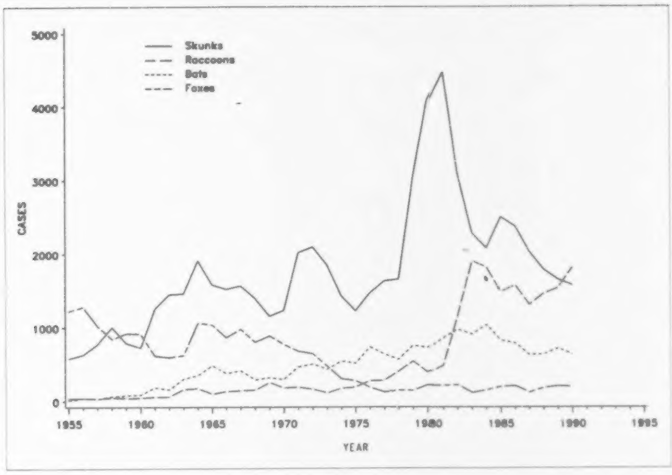

Figure 3—Cases of rabies in wild animals in the United States, by year and species, 1955 to 1990.

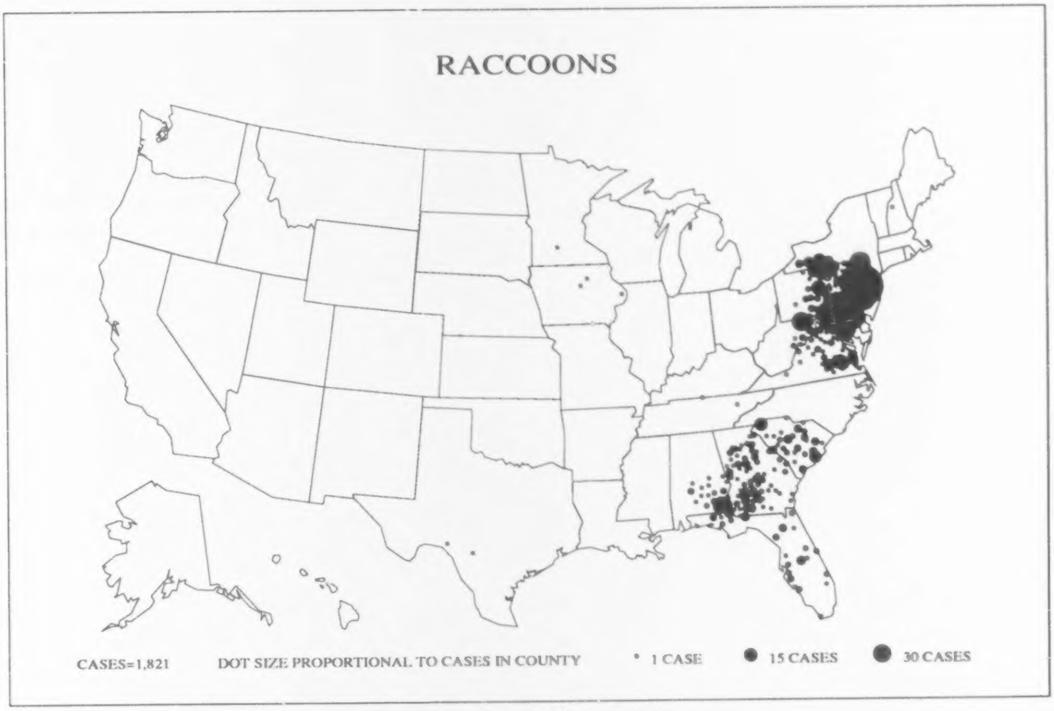

Figure 4—Reported cases of rabies in raccoons, by county, 1990.

raccoons reported in 1990. New Jersey reported the highest number of rabid raccoons (408) in 1990, a 22.6-fold increase in the state since the first 18 cases were reported in 1989. By Dec 31, 1990, six counties were affected by the epizootic in New Jersey, up from two counties in 1989. The epizootic has spread in New Jersey at the rate of approximately 25 km/yr. Pennsylvania reported 405 rabid raccoons, a 17.8% decrease from 1989; Virginia reported 129 cases in 1990, a 12.8% decrease from 1989. Other states affected by the epizootic that reported increases were Delaware (76.2%) and Maryland (29.5%). Florida, Alabama, and Georgia reported substantial decreases in the number of rabid raccoons.

Skunks—Rabies in skunks remained enzootic in most midwestern states and in California (Fig 5). In 1990, 1,579 cases of rabies in skunks were reported to the CDC, a decrease of 4.7% from 1989. However, substantial increases in the number of rabid skunks were reported from adjacent midwestern states: North Dakota (66 cases, an increase of 83.3% from 1989), Minnesota (164 cases, an increase of 65.7%), and South Dakota (145 cases, an increase of 61.1%). Together with Iowa (122

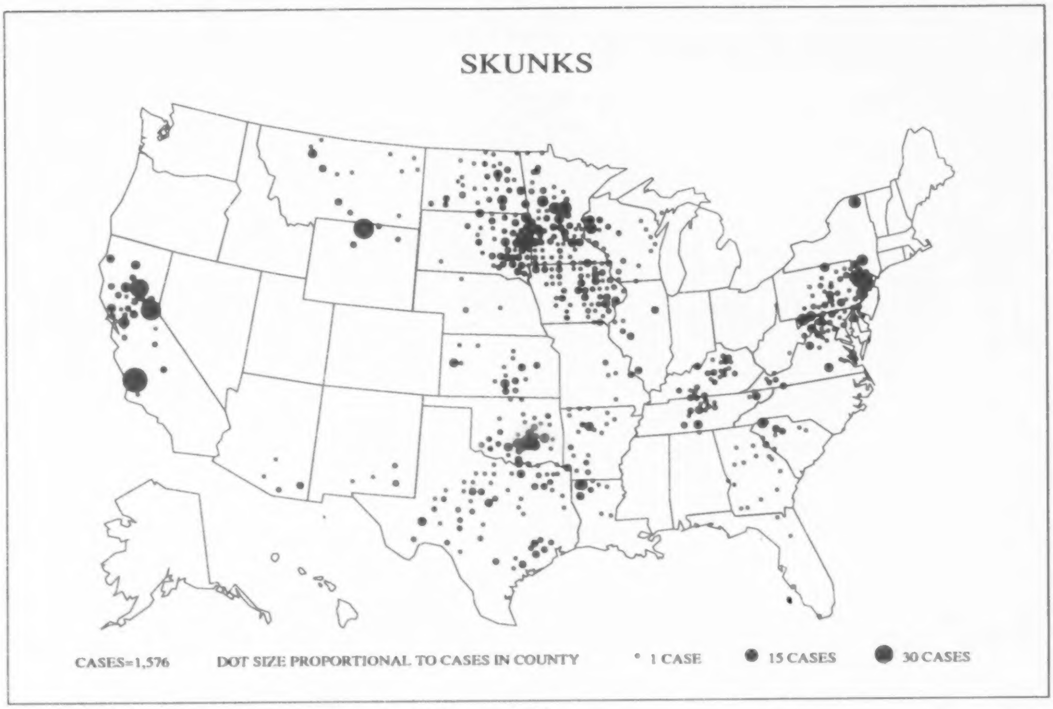
SKUNKS
CASES=1,576
DOT SIZE PROPORTIONAL TO CASES IN COUNTY
1 CASE
15 CASES
30 CASES

Figure 5—Reported cases of rabies in skunks, by county, 1990.

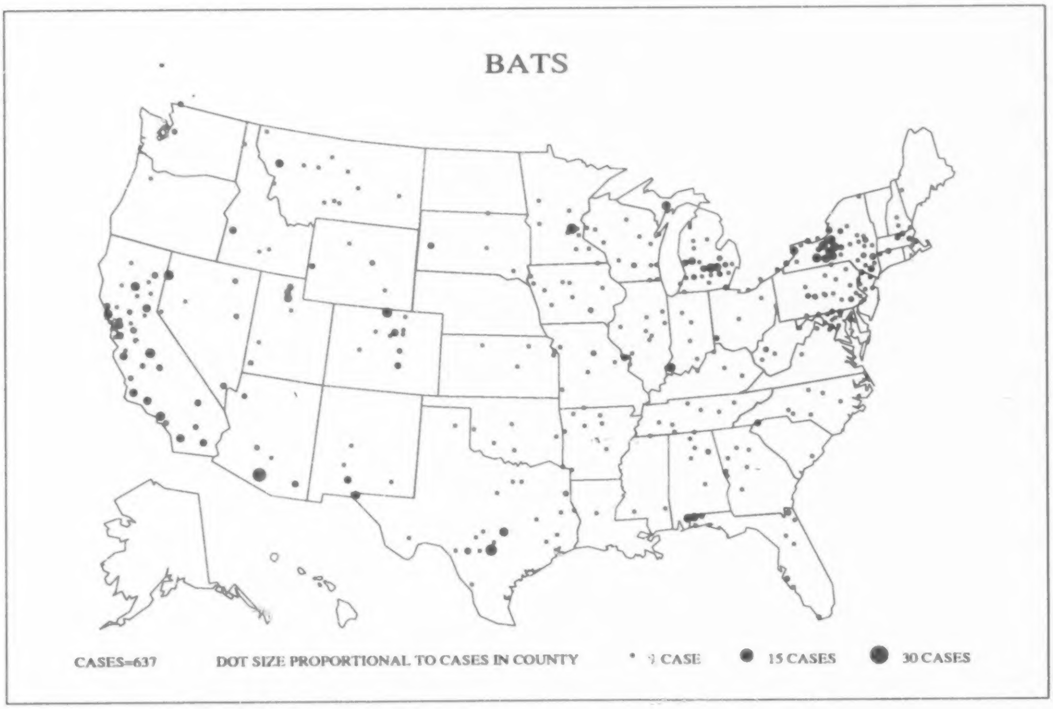
BATS
CASES=637
DOT SIZE PROPORTIONAL TO CASES IN COUNTY
1 CASE
15 CASES
30 CASES

Figure 6—Reported cases of rabies in bats, by county, 1990.

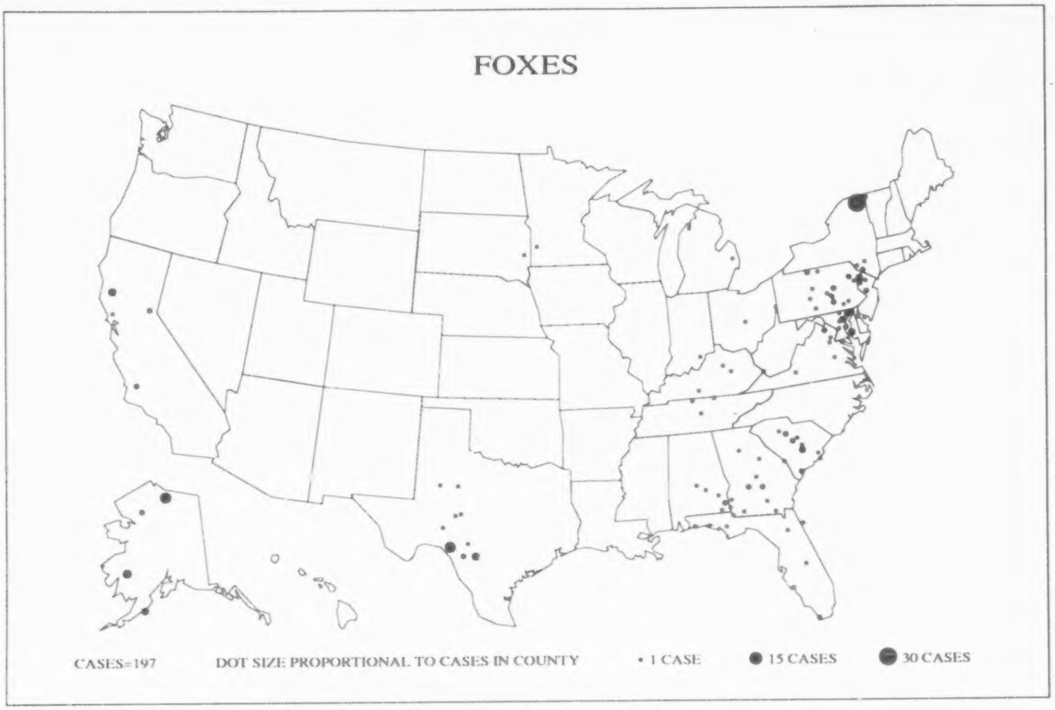
FOXES
CASES=197
DOT SIZE PROPORTIONAL TO CASES IN COUNTY
• 1 CASE
● 15 CASES
● 30 CASES

Figure 7—Reported cases of rabies in foxes, by county, 1990.

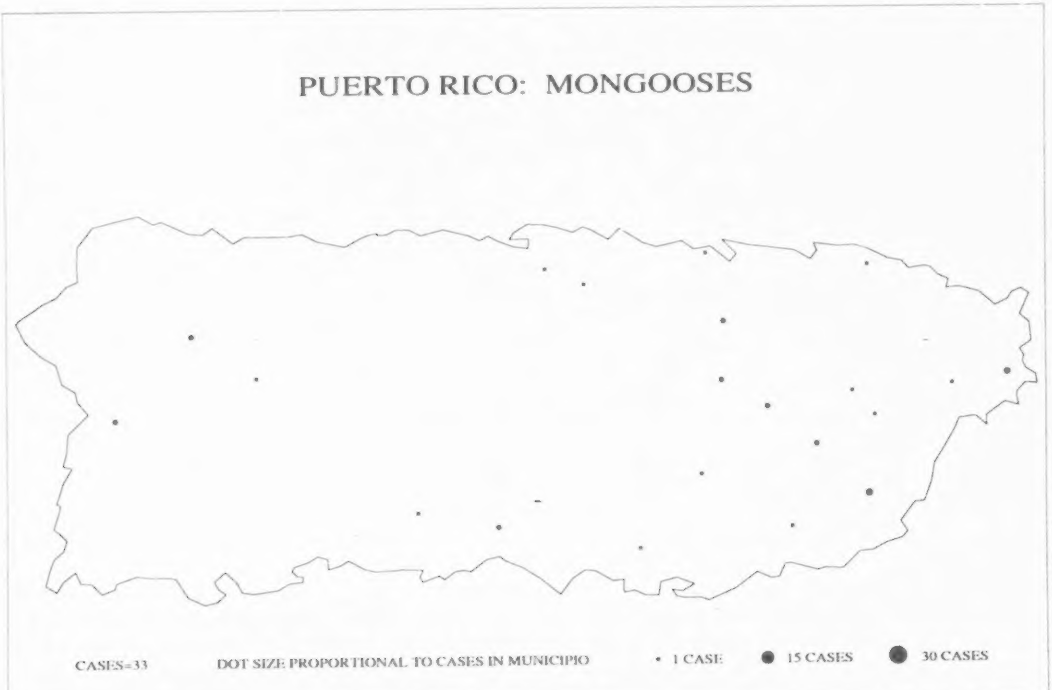
PUERTO RICO: MONGOOSES
CASES=33
DOT SIZE PROPORTIONAL TO CASES IN MUNICIPIO
• 1 CASE
● 15 CASES
● 30 CASES

Figure 8—Reported cases of rabies in mongooses, by municipio, Puerto Rico, 1990.

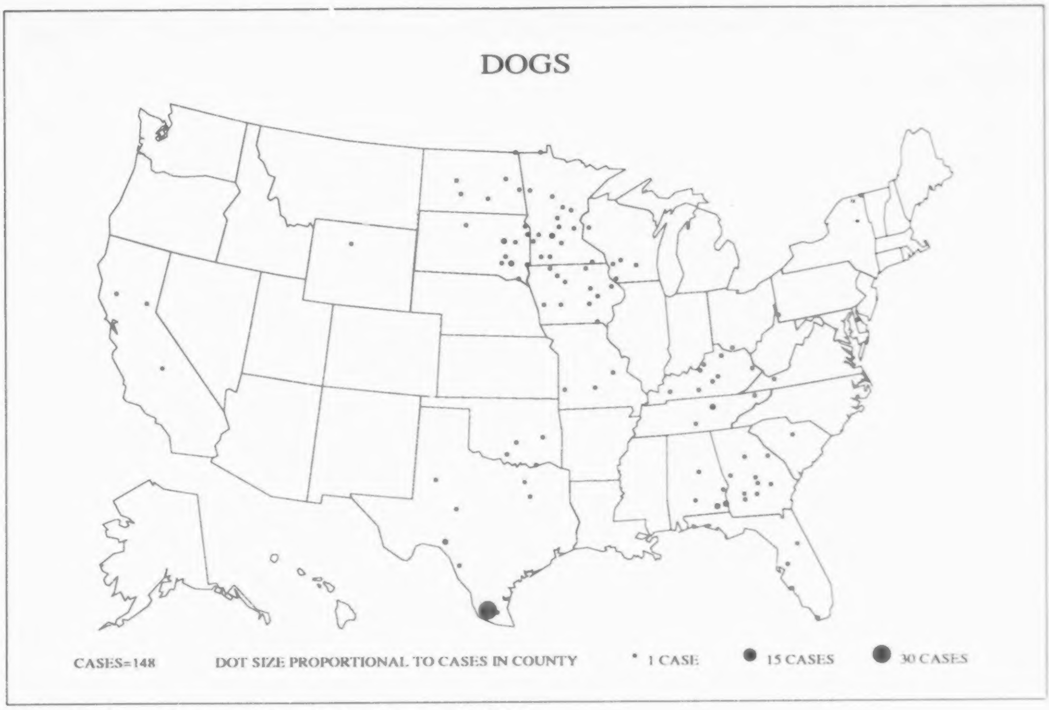

Figure 9—Reported cases of rabies in dogs, by county, 1990.

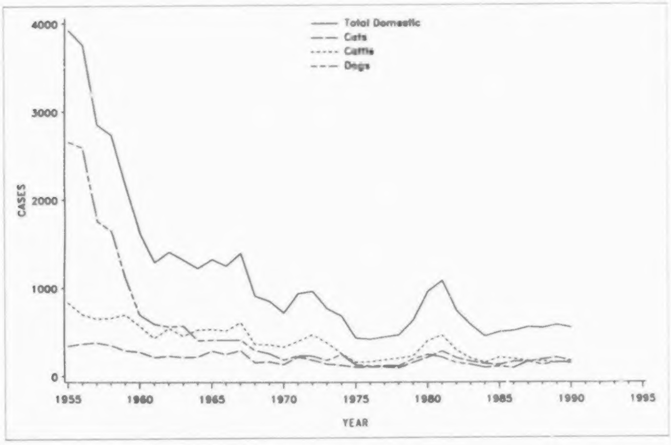

Figure 10—Cases of rabies in domestic animals in the United States, by year, 1955 to 1990.

cases), these midwestern states accounted for 31.5% of all reported cases of rabies in skunks. Other states reporting large numbers of rabid skunks were California (230 cases, a decrease of 13.5% from 1989) and Texas (117 cases, a decrease of 49.4%).

Bats—The number of reported cases of rabies in bats decreased by 11.5%, from 720 in 1989 to 637 in 1990. Rabies in bats continued to be widely distributed throughout the United States, with cases reported from all but eight of the 48 contiguous states (Fig 6). California again had the largest number of cases (105) in 1990, although this represented a decrease of 10.3% from 1989. New York reported the second largest number of rabid bats (84) in 1990, a 55.6% increase from 1989.

Other wild animals—Foxes accounted for 4.6% of all rabies in wild animals in 1990, a decrease of 4.8% from 1989. A rabies epizootic in foxes appears to be reemerging in northern New York, where 34 cases were reported in 1990, compared with none in 1989 (Fig 7). Puerto Rico reported 33 cases of rabies in mongooses, a decrease of 42.1% from 1989 (Fig 8). Other wild animals reported rabid included 25 groundhogs (8 each from New Jersey and Pennsylvania, 4 from Maryland, 2 from Wisconsin, and 1 each from Delaware, Iowa, and

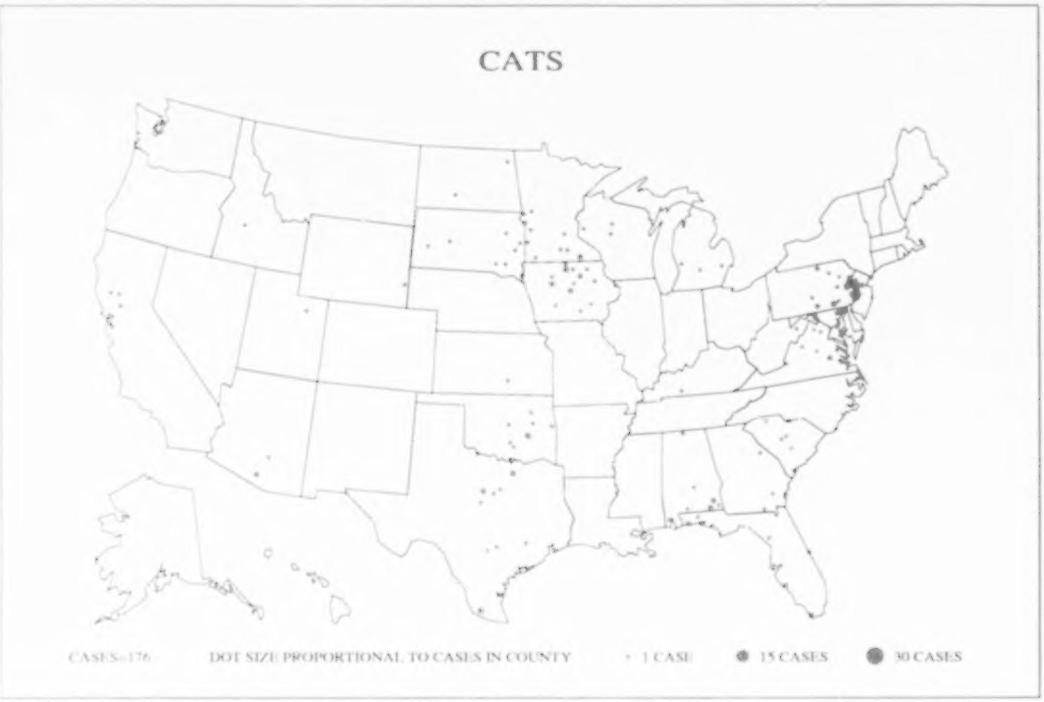
CATS
CASES=176
DOT SIZE PROPORTIONAL TO CASES IN COUNTY
• 1 CASE
● 15 CASES
● 30 CASES

Figure 11—Reported cases of rabies in cats, by county, 1990.

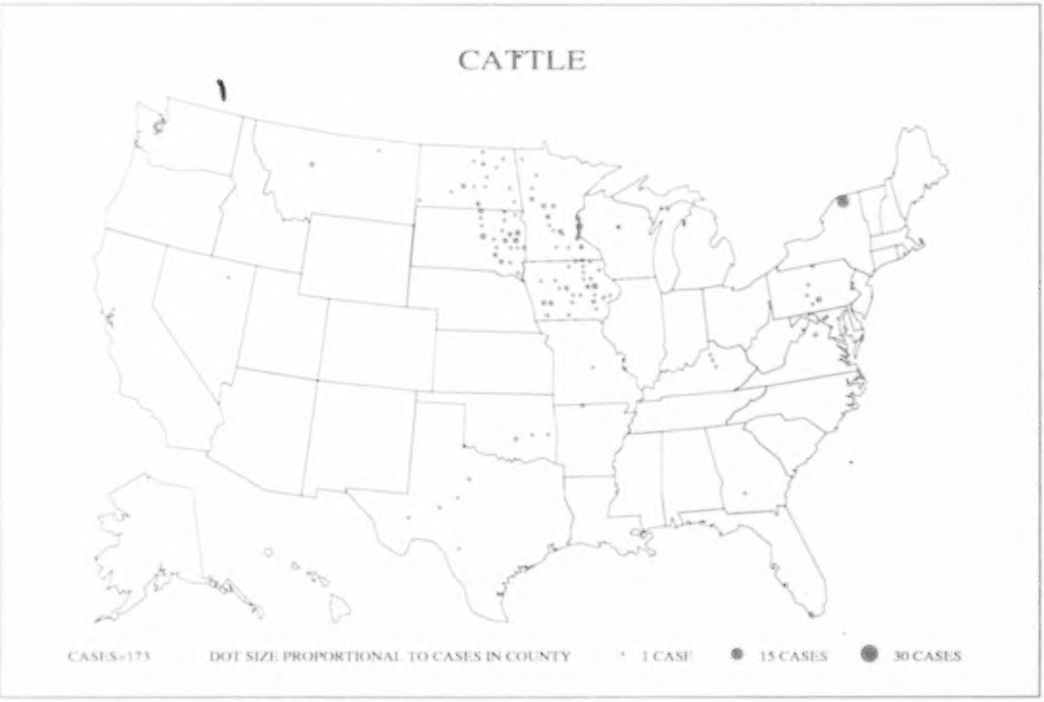
CATTLE
CASES=173
DOT SIZE PROPORTIONAL TO CASES IN COUNTY
• 1 CASE
● 15 CASES
● 30 CASES

Figure 12—Reported cases of rabies in cattle, by county, 1990.

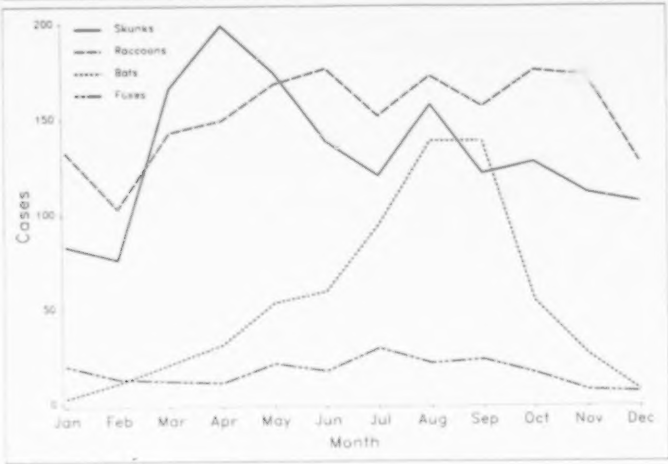

Figure 13—Cases of rabies in wild animals in the United States, by month, 1990.

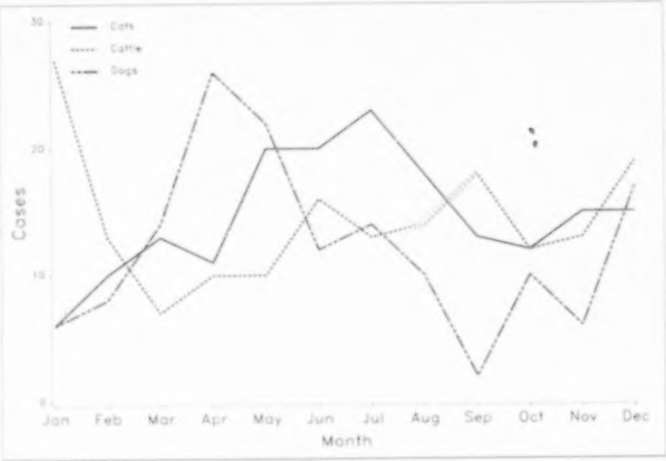

Figure 14—Cases of rabies in domestic animals in the United States, by month, 1990.

North Dakota), 15 bobcats, 6 coyotes, 2 deer, 2 otters, 2 opossums, 1 rabbit, 1 squirrel, and 1 shrew.

Rabies in Domestic Animals

Rabies in domestic animals continued to account for a small proportion (11.3%) of all rabid animals in the United States. With the exception of Texas, rabies in domestic animals tended to be sporadic, with isolated cases in areas endemic for rabies in wildlife. The number of reported rabid domestic animals decreased by 5.3%, from 584 cases in 1989 to 553 in 1990.

Dogs—The number of cases of rabies in dogs decreased 7.5%, from 160 cases in 1989 to 148 in 1990. Texas reported the largest number of rabid dogs (40 cases, a decrease of 6.9% from 1989), virtually all of which were attributable to a rabies epizootic in dogs in Starr and Hidalgo counties that began in 1987. Minnesota, Iowa, and South Dakota each reported 11 to 13 cases of rabies in dogs (Fig 9). These states also reported high numbers of rabid skunks.

Cats—The number of rabid cats exceeded that of any other domestic animal for the third consecutive year (Fig 10). The 176 cases reported in 1990 represented a 16.9% decrease from 1989 (212 cases). Texas, Oklahoma, and Alabama reported increases in the number of rabid cats in 1990. Other states reporting large numbers of rabid cats include Pennsylvania (34 cases), Iowa (19 cases), Texas (14 cases), Maryland (11 cases), Minnesota (11 cases), and Virginia (11 cases; Fig 11).

Other domestic animals—The number of cases of rabies in cattle in 1990 was 173, a 14.6% increase from 1989 (Fig 12). The distribution of rabies in cattle closely followed that of skunks. Iowa reported the largest number of rabid cattle (35), although this was a decrease of 18.6% from 1989. Minnesota (23 cases), North Dakota (17 cases), and South Dakota (31 cases) reported increases in the number of rabid cattle in 1990.

Seasonality

A number of temporal trends are evident when rabies cases are evaluated among different species by month. The frequency of rabies in skunks peaked in April (199 cases), which was 68 cases more than the monthly mean of 131 for the rest of 1990. Rabies in bats increased steadily, reaching a peak in August and September, each with 138 cases. The frequency of rabies in raccoons had three less distinct peaks in June (176 cases), October (175 cases), and November (172 cases; Fig 13). The frequency of rabies in dogs peaked in April (26 cases), the frequency of rabies in cats peaked in July (23 cases), and the frequency of rabies in cattle peaked in January (27 cases; Fig 14).

Rabies in a human being

On June 5, 1990, a 22-year-old man died of rabies encephalitis in Hidalgo County, Texas, along the Mexican border. This was the fourth case of rabies in a human being known to be acquired in the United States since 1980 and the first case in Texas since 1985. The man was bitten by a bat that was not submitted for rabies testing and he did not seek medical treatment. Monoclonal antibody typing suggested that the rabies variant was the Mexican free-tailed bat (*Tadarida brasiliensis mexicana*).[4]

Rabies in Canada and Mexico

Canada reported 2,319 laboratory-confirmed and 172 clinically diagnosed cases of rabies in domestic and wild animals in 1990, a 7.5% increase over the total number of cases in 1989. This increase was attributed to the larger number of reported rabid foxes and cattle (1,167 and 467 cases, respectively), representing increases of 15 and 29.4%, respectively, from 1989. Other species reported rabid were skunks (18.8% of the total), cats (4.3% of the total) and dogs (3.5% of the total). Human cases were not reported from Canada for 1990.

Mexico reported 3,325 laboratory-confirmed and 6,007 clinically diagnosed cases of rabies in domestic and wild animals in 1990. Dogs accounted for 93.5% (8,723 of 9,332) of all reported cases of rabies in animals. Rabies was reported in 69 human beings, an increase of 6.2% from 1989. The majority of these (87%; 60 of 69) had been exposed to rabid dogs.

Discussion

Among the most important developments in 1990 was the continued spread of the rabies epizootic in raccoons; the epizootic expanded in New Jersey, resulting in a marked increase in reported cases, and entered the state of New York. During 1990, the reported number of cases of rabies in raccoons exceeded that in skunks for the first time. Urban areas provide a suitable habitat for raccoons, and dense populations of human beings and pets in these areas lead to more wildlife encounters that result in submission of wild animals for testing. This epizootic will likely continue to spread to other states in the densely populated New England region. Other important developments include the increase in the total number of cases of terrestrial rabies and the appearance of 34 cases of rabies in foxes in New York, an indication of the reemergence of the epizootic stretching from Canada.

Between 1980 and 1990, 13 cases of rabies in human beings were reported in the United States, but only four (30.8%) of these infections were acquired in the United States. Monoclonal antibody analysis and evaluation of exposure history have demonstrated that 3 of these 4 cases acquired in the United States resulted from exposure to bats.

Bats infected with rabies are found in all regions of the continental United States. During 1990, 43 states reported cases of rabies in bats. Several species are affected, but the Mexican free-tailed bat is the most important vector of rabies in the southwestern states where rabies isolation rates vary from 0 to 5% in bats displaying abnormal behavior.[5]

1991 rabies update

The rabies epizootic in raccoons in the mid-Atlantic states has continued to spread within New Jersey and New York and into Connecticut and North Carolina. New Jersey and New York reported 482 and 246 cases of rabies in raccoons during the first 6 months of 1991, respectively. In April 1991, the first case in Connecticut was reported from Fairfield County, and between April and July, 22 cases of rabies in raccoons were reported. In addition, the first case in North Carolina was reported from Gates County in April, 1991.

Three cases of rabies in human beings in the United States were reported to the CDC in 1991. Two of these cases were reported in August, one was a 55-year-old woman from Starr County in Texas and the other was a 29-year-old man from Clark County, Arkansas. The third case, reported in October, was a 27-year-old woman from Walker County, Georgia. Monoclonal antibody typing suggested that the rabies variants from the Arkansas and Georgia patients were that commonly found in the silver-haired bat (*Lasionycteris noctivagans*). Although exposure to rabies was not reported for the woman from Texas, a variant consistent with the Mexican dog or coyote strain was isolated from her saliva, and she lived in one of the two counties in the United States where rabies continues to be transmitted from dog to dog. The Arkansas man had had contact with a bat (not submitted for testing) and he did not seek antirabies prophylaxis. The woman from Georgia had no known contact with a bat.

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A3100-2

April 15, 1992, Volume 200, Number 8

JOURNAL

OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

Tour through Dubois

Joyce M. Nanos

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 200 April 15, 1992 No. 8
JAVMA 200 (8) 1049-1176 (1992)
ISSN 0003-1488

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About the cover

Since moving eight years ago to Dubois, Wyoming, Joyce M. Nanos has been a full-time artist whose subject matter concerns the Dubois area and its residents. Her son-in-law, Dr. Daniel Otto, is a veterinarian in McCook, Nebraska.

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AAVMC reports on veterinary medical degree enrollment, 1991-1992

Statistical information provided by the Association of American Veterinary Medical Colleges (AAVMC) indicates that in the 1991-1992 academic year, total enrollment in DVM-degree programs in the United States and Canada increased by 19, compared with a decline of 31 in 1990 and a decline of 104 in 1989. Enrollment in the Canadian colleges decreased by 1, whereas enrollment in the US colleges increased by 20. For the 1991-1992 academic year, 9,602 students were enrolled (*see* Table 1), including 8,440 in the United States and 1,162 in the Canadian colleges.

Continued on 1068

TABLE 1—Enrollment in US and Canadian veterinary medical degree programs

	Male		Female		Total
	No.	%	No.	%	No.
United States	3,202	38	5,238	62	8,440
Canada	395	34	767	66	1,162
Total	3,597	38	6,005	63	9,602

TABLE 2—Enrollment in US and Canadian graduate-degree and certificate programs

Graduate	MS	PhD	Certificate of internship	Certificate of residency	Certificate of residency and MS	Certificate of residency and PhD	Total
DVM	403	736	144	295	266	61	1,905
Non-DVM	491	652	0	0	0	0	1,143
Total	894	1,388	144	295	266	61	3,048

TABLE 3—Enrollment of veterinary medical degree students in the United States and Canada by class year

College	1st year	2nd year	3rd year	4th year	Total
Auburn University	90	86	85	79	340
California, University of	123	122	122	116	483
Colorado State University	127	130	118	127	502
Cornell University	81	81	78	78	318
Florida, University of	80	80	80	80	320
Georgia, University of	80	71	73	68	292
Illinois, University of	87	80	74	80	321
Iowa State University	101	74	74	66	315
Kansas State University	88	82	98	91	359
Louisiana State University	74	64	56	57	251
Michigan State University	101	115	76	100	392
Minnesota, University of	75	73	56	61	265
Mississippi State University	42	44	48	42	176
Missouri, University of	64	63	63	62	252
North Carolina State University	72	71	72	62	277
The Ohio State University	128	123	120	126	497
Oklahoma State University	67	70	62	53	252
Oregon State University	35	0	0	32	67
Pennsylvania, University of	111	101	105	98	415
Purdue University	70	65	67	58	260
Tennessee, University of	57	57	54	51	219
Texas A&M University	118	110	121	115	464
Tufts University	75	66	72	68	281
Tuskegee University	57	55	43	53	208
Virginia Polytechnic Institute	79	77	76	74	306
Washington State University	59	94	91	59	303
Wisconsin, University of	84	69	78	74	305
Total, US colleges	2,225	2,123	2,062	2,030	8,440
Guelph, University of	100	102	102	101	405
Montreal, University of	74	72	72	70	287
Saskatchewan, University of	70	70	70	70	280
Prince Edward Island, University of	52	49	45	44	190
Total, Canadian colleges	296	293	289	285	1,162
Total, US and Canadian colleges	2,521	2,416	2,351	2,315	9,602

TABLE 4—Geographic distribution of entering class of veterinary students in US colleges

Universities

Residence	Auburn	California	Colorado	Cornell	Florida	Georgia	Illinois	Iowa	Kansas	Louisiana	Michigan	Minnesota	Mississippi	Missouri	North Carolina	Ohio	Oklahoma	Oregon	Pennsylvania	Purdue	Tennessee	Texas A&M	Tufts	Tuskegee	Virginia Tech.	Washington	Wisconsin	Total
Alabama	46	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	9	...	...	...	56
Alaska	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	4
Arizona	...	1	14	...	1	...	...	...	...	...	...	...	...	...	...	...	2	1	1	1	...	...	...	...	...	1	1	23
Arkansas	...	...	...	...	...	...	...	...	...	19	...	...	...	4	...	...	3	...	...	...	...	...	...	1	...	...	...	27
California	...	119	2	2	1	...	...	6	1	...	2	3	2	1	...	...	4	...	2	3	...	...	...	4	...	3	2	157
Colorado	...	...	60	...	...	...	...	1	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	63
Connecticut	1	...	...	2	...	2	...	...	...	...	...	1	...	...	2	...	2	...	6	2	...	...	6	1	...	...	...	25
Delaware	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	3
District of Columbia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	3
Florida	1	1	...	1	65	...	...	2	...	...	1	...	1	...	...	...	...	...	2	1	1	...	...	2	...	...	1	79
Georgia	...	...	...	...	...	55	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	1	...	...	...	58
Hawaii	1	...	3	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...	6
Idaho	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	11	...	12
Illinois	1	...	...	...	...	...	82	4	...	...	1	2	...	1	...	...	...	...	1	2	2	...	...	1	...	...	2	99
Indiana	...	...	...	...	...	...	1	...	...	...	1	...	...	1	...	...	...	...	...	36	...	...	...	...	...	...	...	39
Iowa	...	...	...	...	...	...	...	58	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	58
Kansas	...	...	...	...	...	...	...	...	43	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	43
Kentucky	34	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	36
Louisiana	...	...	...	...	...	...	...	...	...	50	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	51
Maine	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	...	...	...	...	6
Maryland	...	...	...	2	2	2	...	2	...	...	1	1	...	...	2	1	2	...	2	...	1	...	...	6	30	...	...	54
Massachusetts	...	...	...	...	2	...	1	...	...	...	1	3	...	...	...	...	...	...	4	1	1	...	53	...	...	...	...	66
Michigan	...	...	...	...	1	...	1	2	1	...	83	1	...	...	...	1	...	...	...	1	...	...	...	1	...	...	...	92
Minnesota	...	...	...	...	...	...	...	1	...	...	...	42	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	44
Mississippi	...	...	...	...	...	...	...	...	...	...	...	...	28	...	...	...	...	...	...	...	...	...	...	1	...	...	...	29
Missouri	...	...	...	...	...	...	...	...	...	...	...	...	...	50	...	1	...	...	...	...	...	...	...	...	...	...	1	52
Montana	...	...	8	...	...	...	...	...	1	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	2	...	12
Nebraska	...	...	...	...	...	...	...	...	33	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	34
Nevada	...	...	2	...	...	...	...	2	...	...	...	...	...	1	...	2	...	...	...	...	...	...	...	...	...	1	...	8
New Hampshire	...	...	...	2	...	...	...	...	...	...	...	1	...	...	...	3	...	...	...	...	...	...	1	...	...	...	...	7
New Jersey	...	...	...	6	2	1	...	3	...	...	2	2	1	3	...	5	...	...	13	3	2	...	2	8	...	...	...	53
New Mexico	...	1	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	18
New York	...	...	...	61	4	...	1	3	...	2	4	3	2	...	2	1	1	...	13	1	4	...	1	1	...	...	1	105
North Carolina	...	...	...	...	...	1	...	...	...	...	...	...	...	...	62	...	...	...	...	...	...	...	...	5	...	...	...	68
North Dakota	...	...	...	...	...	...	...	7	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9
Ohio	...	...	...	...	...	...	...	...	...	1	2	...	...	...	...	106	...	...	...	...	...	...	1	...	...	...	...	110
Oklahoma	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	46	...	...	...	...	...	...	...	...	...	...	47
Oregon	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	28	...	...	...	...	1	...	...	...	...	29
Pennsylvania	...	...	1	...	1	...	...	1	1	...	1	3	...	...	1	2	1	...	58	8	4	...	2	1	...	...	...	85
Puerto Rico	...	...	1	1	...	...	...	2	1	1	...	...	1	1	...	1	...	...	...	2	1	...	...	6	...	...	...	18
Rhode Island	...	...	...	...	...	...	...	1	...	...	...	2	...	...	...	...	...	...	1	1	...	...	2	1	...	...	...	8
South Carolina	...	...	...	...	...	13	...	...	...	...	...	...	1	...	2	...	...	...	...	...	...	...	...	1	...	...	...	17
South Dakota	...	...	...	...	...	...	...	1	3	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6
Tennessee	1	...		...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	37	...	...	...	...	...	...	40
Texas	1	...	...	...	...	...	...	1	...	1	...	1	2	...	...	...	1	...	...	...	...	118	...	2	...	1	...	128
Utah	...	...	8	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	...	11
Vermont	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1	...	3
Virginia	...	...	...	1	1	1	...	...	...	...	...	...	1	...	1	...	2	...	...	1	1	...	...	2	49	...	1	61
Washington	...	...	...	...	...	...	1	1	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	1	...	36	...	41
West Virginia	1	...	...	...	...	5	...	...	...	...	...	...	...	...	...	5	...	...	...	...	...	...	...	...	...	...	...	11
Wisconsin	...	...	...	...	...	...	...	1	...	...	1	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	74	80
Wyoming	...	...	8	...	...	...	...	...	3	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	1	...	14
Bahamas	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1
Canada	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	1	...	...	...	...	...	...	...	4
Germany	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1
Jamaica	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1	...	...	...	3
Peru	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1
South Africa	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1
Spain	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
Sweden	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
Switzerland	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1
Trinidad	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1	...	...	...	2
Total	90	123	127	81	80	80	87	101	88	74	101	75	42	64	72	128	67	35	111	70	57	118	75	57	79	59	84	2,225

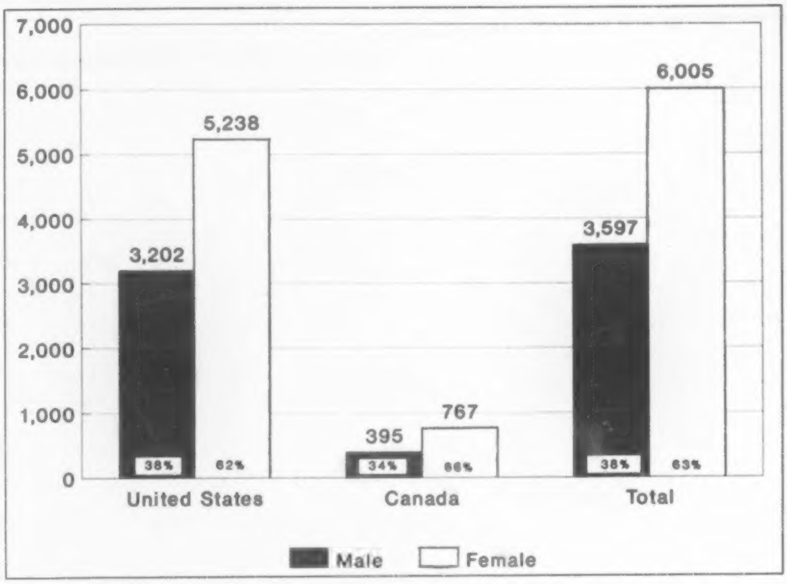
AAVMC . . . from 1066

Of the total enrollment in US veterinary medical degree programs, 62% of the students were female (*see* bar graph). This compares with 60% in 1990-1991 and 59% the preceding year.

First-year enrollment in the US colleges increased by 28 students after three years of nearly stable first-year enrollment.

Total enrollment in US and Canadian graduate-degree and certificate programs in 1991-1992 is 3,048 (*see* Table 2), up by 401 participants over 1990-1991. The 1991-1992 total includes 1,905 with and 1,143 without DVM or VMD degrees.

Enrollment by class is presented in Table 3, and geographic distribution of first-year students in the US veterinary colleges is shown in Table 4.



The graph above exemplifies a growing trend among veterinary students. Today, nearly two thirds of them in North America are women.

Prepared by the AVMA Center for Information Management.

Lectures at Tuskegee, Cornell to celebrate corporation's centennial

As part of its 100th anniversary celebration, Merck & Company, Inc, has awarded the Tuskegee University School of Veterinary Medicine and the Cornell University College of Veterinary Medicine each a $10,000 grant to conduct a Merck Centennial Lecture Series at the universities.

The lecture series is one of a number of events that is celebrating Merck & Company's 100th anniversary. The company will be donating $6 million in grants to educational institutions and community organizations around the country during 1992.

Tuskegee and Cornell are two of 25 institutions selected to participate in the centennial lecture segment of the celebration. The lecture complements Tuskegee's and Cornell's academic programs that acquaint students with contemporary veterinary medical issues and introduce them to leading researchers from other institutions.

Animal care program accredited

A new Campus Central Animal Facility was completed and occupied recently at the University of Arizona, Tucson. The facility consolidated and centralized animal care services on the main campus. In addition, the University maintains a facility on the north campus for the Arizona Health Sciences Center as well as four agricultural farms and an environmental research center.

The entire University animal care and use program is administered by a central management unit, University Animal Care, which is directed by Dr. John Mulder. Seven other veterinarians and a staff of 50 support and technical personnel are affiliated with the program. Full accreditation recently was conferred on the program by the American Association for Accreditation of Laboratory Animal Care.

Special Report

1990 Report of the American Association of Poison Control Centers: Poisonings in animals

Carl S. Hornfeldt, MS, and Michael J. Murphy, DVM, PhD

The primary functions of a poison center are to provide poison information, telephone consultation of the management of poison exposures (Appendix), collection of epidemiologic data on poison exposures, and public and professional education. The American Association of Poison Control Centers (AAPCC) was formed to facilitate the functions of poison centers by promoting activities designed to improve the prevention and treatment of poisonings, the exchange of information concerning poison experience, and to develop protocols and policies to guide the activities of poison centers.[1]

Because the means for collecting and reporting national poison center data was inefficient, the AAPCC developed a data collection system that could be tailored to the needs of each poison center and still permit each center to contribute data to a national data base. In 1982, with the support of the FDA, the AAPCC Data Collection Committee developed the necessary computer software for data manipulation and a Cooperative Poison Center Report Form, including a machine-readable data collection form.[2]

Following a successful trial use in 1983, this system was made available to all poison centers in 1984. Since that time, the Annual Report of the American Association of Poison Control Centers National Data Collection System has been published each year in the September issue of the *American Journal of Emergency Medicine*, providing the largest and most detailed summary of human poison exposures available. The AAPCC National Data Collection System has grown from 16 centers reporting 251,012 human poison exposures in 1983 to 72 centers reporting 1,713,462 exposures in 1990.

Although the emphasis of the aforementioned data collection system has been placed on documenting poison experience in humans beings, information on poison exposures in animals has been collected as well. In 1983, 4,643 animal poisonings were reported to the AAPCC.[2] Currently, this number has grown to 41,854. Unfortunately, several shortcomings with the current data collection system exist with regard to animal exposures. For example, no mechanism for collecting species-specific information exists at this time. On the basis of a sample of 3,801 animal cases (9% of the total), we assumed that approximately 99% of the

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From the Hennepin Regional Poison Center, Hennepin County Medical Center, 701 Park Ave, Minneapolis, MN 55415 (Hornfeldt) and the Department of Veterinary Diagnostic Medicine, College of Veterinary Medicine, University of Minnesota, St Paul, MN 55108 (Murphy).

Address reprint requests to AAPCC, 3800 Reservoir Rd NW, Washington DC, 20007.

Centers participating in this report include: Children's Hospital of Alabama Regional Poison Control Center, Birmingham, Ala; Alabama Poison Center, Tuscaloosa, Ala; Arizona Poison and Drug Information Center, Tucson, Ariz; Samaritan Regional Poison Center, Phoenix, Ariz; University of California Davis Medical Center Regional Poison Control Center, Sacramento, Calif; Santa Clara Valley Medical Center Regional Poison Center, San Jose, Calif; Fresno Regional Poison Control Center, Fresno, Calif; Rocky Mountain Poison and Drug Center, Denver, Colo; National Capital Poison Center, Washington, DC; Florida Poison Information Center, Tampa, Fla; Georgia Poison Control Center, Atlanta, Ga; Idaho Poison Control Center, Boise, Idaho; Indiana Poison Center, Indianapolis, Ind; St. Luke's Poison Center, Sioux City, Iowa; Kentucky Regional Poison Center of Kosair Children's Hospital, Louisville, Ky; Blodgett Regional Poison Center, Grand Rapids, Mich; Saginaw Region Poison Center, Saginaw, Mich; Minnesota Regional Poison Center, St. Paul, Minn; Hennepin Regional Poison Center, Minneapolis, Minn; New Jersey Poison Information and Education System, Newark, NJ; New Mexico Poison and Drug Information Center, Albuquerque, NM; Finger Lakes Regional Poison Center, Rochester, NY; Cincinnati Drug and Poison Information Center, Cincinnati, Ohio; Akron Regional Poison Center, Akron, Ohio; Western Ohio Poison and Drug Information Center, Dayton, Ohio; Greater Cleveland Poison Control Center, Cleveland, Ohio; Mahoning Valley Poison Center, Youngstown, Ohio; Stark County Poison Control Center, Canton, Ohio; Pittsburgh Poison Center, Pittsburgh, Pa; Delaware Valley Regional Poison Control Program, Philadelphia, Pa; Northwest Regional Poison Center, Erie, Pa; Central Pennsylvania Poison Center, Hershey, Pa; Keystone Region Poison Center, Altoona, Pa; Hamot Poison Information Center, Erie, Pa; Middle Tennessee Regional Poison and Clinical Toxicology Center, Nashville, Tenn; Southern Poison Center Inc, Memphis, Tenn; North Texas Poison Center, Dallas, Tex; Virginia Poison Center, Richmond, Va; Blue Ridge Poison Center, Charlottesville, Va; Tidewater Poison Center, Norfolk, Va; Seattle Poison Center, Seattle, Wash; Mary Bridge Poison Center, Tacoma, Wash; Spokane Poison Center, Spokane, Wash; Central Washington Poison Center, Yakima, Wash; West Virginia Poison Center, Charleston, WVa; University of Wisconsin Hospital Regional Poison Center, Madison, Wis; Green Bay Poison Center, Green Bay, Wis.

cases in this report represent poisonings in companion animals, with about 75% in dogs, 20% in cats, and 4% in other pets.[3] The contribution of information on animal poisonings to the National Data Collection System is voluntary at this time, with animal data provided by only 47 of 72 participating centers. Finally, because animal cases are not subjected to accuracy audits, submitted data are not complete in all cases, especially with regard to outcome. For example, a known outcome was determined in 57.2% of all human exposures. By comparison, of 37,625 recorded outcomes in animals, only 35.7% are known; 34.8% are documented as unknown, but were determined to be of a nontoxic nature in 18.5% of cases and potentially toxic in 18.5% of cases. Therefore, the following information contains a number of other or unknown categories. In these instances, percentages given refer to the remaining data. It is hoped that the following information will be of value to veterinarians, veterinary toxicologists, poison center staff and others in their respective practices, and ultimately animal owners.

Review of the data

A total of 41,854 animal exposure cases were reported to the National Data Collection System in 1990. These data reveal that 90.9% of poisonings in animals were accidental in nature; 0.3% were adverse reactions to drugs, food, or other products; and 8.8% of poisonings were attributable to other or unknown causes. Acute poisonings represented 90.2% of all cases, 1% were chronic, and 8.8% were of unknown duration. Route of exposure was recorded for 88.7% of cases; the most common route of exposure was ingestion (76.7%), followed by dermal exposures (2.9%). Inhalation, bites and envenomations, ocular, and parenteral routes each represent <1% of all poison exposures. Although parenteral exposures accounted for only 30 cases, these resulted in 5 deaths. Multiple routes of exposure accounted for 3% of all cases and 8.8% of fatalities; a potentially toxic substance was identified and recorded for 41,662 cases (99.5%); of these, exposure to one substance or product accounted for 97% of all cases and exposures to two or more substances or products accounted for 3% of cases.

There was essentially no difference in call distribution by day of the week during 1990. On an hourly basis, the number of calls steadily increased throughout the day until the hour between 7:00 and 8:00 PM, when the number of calls peaked.

The site of exposure was recorded for 88.7% of cases. These data reveal that although most animal poisonings occurred in or around the home (87.7%), only 67.2% of calls to the poison center originated from the home and 23.2% originated from a health care facility, presumably a veterinary clinic or hospital. More than half (56.7%) of animal poison exposures were treated in a non-health care facility. In 15% of cases, the animal was already in, and in 11.6% referred to, a veterinary clinic or hospital for treatment. Of those animals seen in a health care facility, 31.1% were treated and released, and 15.2% were admitted for care. In 13.3% of cases referred to a veterinarian, the owner refused to have their animal seen. Unfortunately, 44.2% of cases of animals in, or referred to, a veterinary clinic were lost to follow-up evaluation. For example, a veterinarian may have called about an animal en route to their facility, but follow-up evaluation revealed that the animal never arrived. Occasionally, an animal had already been sent home and follow-up evaluation was not possible

Table 1—Initial sign assessment/outcome for animals exposed to a toxin

Initial assessment	Number of animals (%)
Without signs of toxicosis	24,744 (59.1)
With signs of toxicosis	6,999 (16.7)
With signs of toxicosis, unknown whether related	3,808 (9.1)
With signs of toxicosis, unrelated	1,432 (3.4)
Other/unknown	4,871 (11.6)
Total	41,854 (100.0)
Outcome	
No effect	7,318 (17.5)
Minor effect	4,149 (9.9)
Moderate effect	865 (2.1)
Major effect	140 (0.3)
Death	419 (1.0)
Unrelated effect	2,052 (4.9)
Unknown, nontoxic	14,550 (34.8)
Unknown, potentially toxic	7,755 (18.5)
Missing/invalid cases	4,606 (11.0)
Total	41,854 (100.0)

Table 2—Therapy provided to animals exposed to a toxin

Therapy	Number of animals (%)
Decontamination	
Dilution	10,101 (24.1)
Emetic	4,219 (10.1)
Ipecac	355 (0.9)
Other	3,864 (9.2)
Irrigate/Wash	2,947 (7.0)
Activated charcoal	1,174 (2.8)
Cathartic	835 (2.0)
Lavage	326 (0.4)
Specific therapy	
Atropine	367 (0.9)
Anticonvulsants	133 (0.3)
Ethanol	49 (0.1)
Oxygen	34 (<0.1)
Antihistamines	30 (<0.1)
N-acetylcysteine	30 (<0.1)
Dimercaperol	25 (<0.1)
Forced diuresis	25 (<0.1)
Pralidoxime	24 (<0.1)
Alkalinization	19 (<0.1)
Glucose	16 (<0.1)
Antivenin	14 (<0.1)
Naloxone HCl	10 (<0.1)
Cardiopulmonary resusitation	6 (<0.1)
EDTA	6 (<0.1)
Methylene blue	6 (<0.1)
Exchange transfusion	4 (<0.1)
Deferoxamine	3 (<0.1)
Physostigmine	3 (<0.1)
Pyridoxine	3 (<0.1)
Charcoal hemoperfusion	2 (<0.1)
Cyanide antidote	1 (<0.1)
Penicillamine	1 (<0.1)
Peritoneal dialysis	1 (<0.1)
Resin hemoperfusion	1 (<0.1)

Table 3—Outcome of exposure to nondrug products

Toxicant category	No Effect	Minimal Effect	Moderate Effect	Major Effect	Death	Unrelated effect	Unknown effect	Total No. of animals (%)
Adhesives	80	32	4	0	1	16	264	397 (1.1)
Alcohols	28	24	2	2	1	7	83	147 (0.4)
Art/crafts	97	30	3	0	2	25	405	562 (1.5)
Automotive	88	37	10	4	33	11	229	412 (1.1)
Batteries	69	36	1	0	1	2	160	269 (0.7)
Bite/stings	58	118	24	1	9	21	234	465 (1.2)
Building products	57	34	2	0	0	27	179	299 (0.8)
Chemicals	192	142	26	6	18	72	574	1,030 (2.7)
Cleaning products	397	348	57	10	13	147	1,245	2,217 (5.9)
Cosmetics	224	133	14	2	2	38	558	971 (2.9)
Deodorizers	26	23	4	0	1	21	91	166 (0.4)
Fertilizers	185	74	7	0	10	80	476	832 (2.2)
Food poisoning	140	87	15	2	7	22	349	622 (1.7)
Foreign bodies	191	66	8	1	1	35	753	1,055 (2.8)
Fumes/gases	13	13	5	0	7	9	29	76 (0.2)
Fungicides	8	8	3	0	1	9	23	52 (0.1)
Heavy metals	18	18	9	1	13	13	105	177 (0.5)
Herbicides	71	107	36	4	12	128	231	589 (1.6)
Hydrocarbons	199	194	23	2	3	54	620	1,095 (2.9)
Insecticides	1,162	684	237	41	94	466	4,684	7,368 (19.6)
Lacrimators	5	37	1	0	0	1	17	61 (0.2)
Matches/fireworks	37	8	1	0	0	4	105	155 (0.4)
Miscellaneous	28	19	2	0	1	9	88	147 (0.4)
Mushrooms	103	50	12	2	2	18	146	333 (0.9)
Paints	111	62	8	8	3	42	354	588 (1.6)
Plants	833	605	72	1	41	463	2,524	4,539 (12.1)
Rodenticides	891	142	61	21	60	83	1,899	3,157 (8.4)
Swimming pool products	17	11	2	0	0	11	72	113 (0.3)
Tobacco	27	11	3	0	0	6	38	85 (0.2)
Unknown substances	35	25	5	0	10	20	124	219 (0.6)
Total								28,198 (75.4)

Table 4—Outcome of exposure of animals to drug products

Toxicant category	No Effect	Minimal Effect	Moderate Effect	Major Effect	Death	Unrelated effect	Unknown effect	Total No. of animals (%)
Prescription drugs	1,081	455	102	15	28	94	2,917	4,692(12.5)
Over-the-counter drugs								
Analgesics	154	84	29	7	5	11	375	665 (1.8)
Antacids, antidiarrheals, laxatives	90	25	9	0	0	14	303	441 (1.2)
Cough and cold	104	78	19	2	1	11	255	470 (1.2)
Electrolytes, minerals	31	31	2	1	1	10	120	196 (0.5)
Eye, ear, nose, throat	58	30	1	0	0	5	141	235 (0.6)
Miscellaneous	5	3	1	0	0	0	16	25 (0.1)
Topicals	183	185	13	1	6	44	703	1,135 (3.0)
Vitamins	85	19	2	0	1	2	170	279 (0.7)
Veterinary drugs	36	25	9	1	6	10	101	188 (0.5)
Drugs of abuse	52	48	15	1	2	3	155	279 (0.7)
Unknown drug	122	72	38	9	31	51	499	822 (2.2)
Total								9,427(25.0)

because the treating veterinarian had left for the day.

In 59.1% of cases, animals did not have signs of toxicosis when the poison center was contacted; in 16.7% of cases, the animal had signs of toxicosis likely to be attributable to the exposure (Table 1). Poison exposure was known to result in no known effect in 19.4% of cases or was believed unlikely to result in a toxic effect in 34.7% (54.1% of all cases). Death was the final outcome reported in 425 animals; unlike human fatalities, however, these could not be verified by necropsy or suitable laboratory analysis. Also, it is unknown whether any reported deaths were attributable to euthanasia. Regrettably, 20.1% of cases were potentially toxic, but the outcome is unknown because the caller refused treatment and/or the case was lost to follow-up evaluation.

Treatment was not required in 24.2% of cases, and simple dilution was recommended in 24.1% of cases, generally because no systemic toxicosis was anticipated yet gastric irritation was possible. In 27.1% of cases, the treatment is unknown, and various therapies were provided in the remaining cases (Table 2). Lavage is assumed to indicate gastric lavage. Unfortunately, some treatments common in veterinary practice, such as vitamin K and apomorphine administration, were not obtained on the AAPCC data collection form.

Animals were exposed to a wide variety of substances and products. Exposures to drug and nondrug substances accounted for approximately

Table 5—Substance involved in fatal poisonings of animals

Substance	Number (%)	
Insecticides	91 (21.4)	
Organophosphates		13 (7.3)
Carbamates		13 (3.1)
Arsenic		1 (0.2)
Chlorinated hydrocarbons		6 (1.4)
Pyrethrins		6 (1.4)
Naphthalene		2 (0.5)
Borates		1 (0.2)
Unknown flea/tick products		15 (3.5)
Other		16 (3.8)
Rodenticides	60 (14.1)	
Anticoagulants		39 (9.2)
Strychnine		6 (1.4)
Zinc phosphide		3 (0.7)
Cholecalciferol		2 (0.5)
Fluoroacetate		1 (0.2)
Vacor		1 (0.2)
Unknown rodenticide		8 (1.9)
Fertilizers	10 (2.4)	
Herbicides	12 (2.8)	
Plants	41 (9.7)	
Gastrointestinal irritants		7 (1.6)
Nontoxic plants		6 (1.4)
Oxalates		5 (1.2)
Cardiac glycosides		4 (0.9)
Cyanogenic glycosides		4 (0.9)
Mushrooms		2 (0.5)
Solanine		2 (0.5)
Dermatitis		2 (0.5)
Stimulants		2 (0.5)
Blue-green algae		2 (0.5)
Unknown plants		5 (1.2)
Medications	82 (19.3)	
Human prescription drugs		28 (6.6)
Human over-the-counter drugs		14 (3.3)
Veterinary		6 (1.4)
Drugs of abuse		3 (0.7)
Unknown drug		31 (7.3)
Miscellaneous	129 (30.2)	
Ethylene glycol & related		41 (9.6)
Teflon		5 (1.2)
Carbon monoxide		4 (0.9)
Metaldehyde		4 (0.9)
Rattlesnake		3 (0.7)
Chocolate		2 (0.5)
Black widow spider		2 (0.5)
Toads		1 (0.2)
Methanol		1 (0.2)
Other/unknown		66 (15.5)

25 and 75% of these cases, respectively (Tables 3 and 4).

The outcome following exposure varied widely between categories. Just over half of the fatalities (Table 5) are accounted for by four categories: insecticides (21.4%), rodenticides (14.3%), ethylene glycol and related compounds (9.6%), and plants (9.6%). More specifically, the three types of products most commonly responsible for death were: ethylene glycol and related compounds (9.6%), anticoagulant rodenticides (9.2%), and organophosphorus insecticides (7.3%).

Appendix: Glossary of terms

Acute—A single, repeated or continuous exposure to the same toxic substance over a period <8 hours.

Chronic—A single or repeated exposure to the same toxic substance lasting longer than 8 hours.

Exposure—An actual or suspected contact with any substance that when ingested, inhaled, absorbed, applied to, or injected into the body may cause damage to structure or disturbance of function to living tissue.

Major effect—The animal had some signs of toxicosis as a result of the exposure. The signs were life-threatening or resulted in residual disability or disfigurement.

Minor effect—The animal had signs of toxicosis as a result of the exposure, but they were minimal and required no treatment.

Moderate effect—The animal had signs of toxicicosis as a result of the expsoure, which were pronounced, more prolonged, or more of a systemic nature than minor signs. Usually some form of treatment would have been indicated. Signs of toxicosis were not life-threatening and the animal eventually returned to a preexposure state of well-being without residual disability or disfigurement.

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A3100-2

May 15, 1992, Volume 200, Number 10

JOURNAL

OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

My Summer Refuge

Donna Kunkel

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 200 May 15, 1992 No. 10
JAVMA 200 (10) 1433-1584
ISSN 0003-1488

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My Summer Refuge was painted by Donna Kunkel, wife of Dr. John Kunkel, an extension veterinarian at the University of Vermont. Her works have been featured in solo and group exhibits and appear in private collections throughout the country.

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SUBSCRIPTIONS: For one year: members $50; others $100 in the United States and possessions; $120 in foreign countries. Single copies: $6 in the United States and possessions; $8 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

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Reports of Retrospective Studies

Locations and types of neoplasms in immature dogs: 69 cases (1964-1989)

Evan T. Keller, DVM, MPVM, and Bruce R. Madewell, VMD, MS

Summary: *Sites, histologic types, and frequencies of neoplasms in immature dogs (≤ 6 months old) were evaluated from data collected over 25 years. The frequencies of neoplasms in immature dogs were compared with those of mature dogs (>6 months old).*

Of 69 immature dogs with neoplasms, 5 had 2 primary neoplasms each, resulting in a total of 74 neoplasms. The 3 most common sites for neoplasia, in decreasing order, were the hematopoietic system, brain, and skin. Immature dogs were 10.9 times more likely to have a neoplasm located in the brain, compared with mature dogs. Immature dogs also were 3.3 times more likely to have a neoplasm associated with the hematopoietic system, compared with mature dogs.

In human beings, the predominant type of neoplasm observed varies according to age group. Neoplasms derived from the hematopoietic system, thyroid gland, testis, and CNS are most prevalent in human beings <29 years old, whereas neoplasms derived from the urinary bladder, colon, and lungs are most prevalent in human beings 50 to 59 years old.[1] Leukemias and neuroblastoma are the most frequently diagnosed fatal neoplastic diseases in children <1 year old.[2]

Few studies have focused on neoplasia in immature dogs. Mulvihill and Priester[3] have reported that the histiocytoma was the most prevalent tumor in dogs <2 years old, and affected dogs were at greatest risk between 6 and 12 months of age. In that study, only 3 tumors were identified in dogs <3 months old; thus, evaluation of tumor location was not done. Data of tumors from records that were derived from schools and colleges of veterinary medicine in the United States and Canada from 1968 through 1979 listed 17,435 microscopically confirmed tumors in dogs, of which 395 were in dogs <1 year old.[4] The tumor data were not categorized to allow examination of specific types or preference sites in immature dogs.

The purposes of the study reported here were to determine the types and locations of neoplasms in immature dogs, and to determine estimates of risk for particular neoplasms in immature vs mature dogs with neoplasia.

Criteria for Selection of Cases

Summaries of medical records of dogs ≤ 6 months old with neoplasia were obtained from data contributed to the Veterinary Medical Data Program (VMDP)[a] between March 1, 1964 and July 1, 1989. Cases were excluded if complete data regarding age of dog or type of neoplasm confirmed histologically were not available.

Data for mature dogs (>6 months) were derived by retabulation of data from an earlier study of the VMDP which only examined data from dogs between March 1, 1964 and June 30, 1977.[4] Thus, only records from immature dogs of the same period as those of the mature dogs were used for statistical comparison.

Statistical analysis

For each tumor site, odds ratios with 95% confidence intervals were generated.[5] Odds ratios were calculated by dividing the ratio of tumors found at a particular site in immature dogs by that in mature dogs. Significance was determined at $P \leq 0.05$. Odds ratios for hemangiosarcoma locations were not determined, because the tumor was found at numerous sites. Locations for this tumor were included in the data from mature dogs.

Results

Of 73 dogs <6 months old with histologically confirmed neoplasms, 4 were excluded because of incomplete data. Of the remaining 69 dogs, 5 had 2 primary tumors each. These dogs included 20 sexually intact females, 10 spayed females, 35 sexually intact males, 3 castrated males, and 1 unknown. Estimates of risk for all gender categories were not significantly different. The most common breeds identified were mixed breed ($n = 20$),

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From the Department of Surgery, School of Veterinary Medicine, University of California, Davis, CA 95616-8745. Dr. Keller's present address is the Department of Medical Sciences, School of Veterinary Medicine, University of Wisconsin, 2015 Linden Dr West, Madison, WI 53706.

[a] Veterinary Medical Data Program; a repository for veterinary medical data located at Purdue University, West Lafayette, Ind.

Golden Retriever (n = 8), German Shepherd Dog (n = 7), Doberman Pinscher (n = 5), and Great Dane (n = 4).

The hematopoietic system, brain, and skin (in decreasing order) were the most frequently affected sites (Fig 1). When records for only those immature dogs with tumors identified between March 1, 1964 and June 30, 1977 were selected, 26 dogs were identified and 2 of them had 2 primary tumors each. The data from these 26 immature dogs were compared with the data from the mature dogs (Table 1). The brain and the hematopoietic system were the only 2 sites in the immature dog with significantly increased estimates of risk.

Data from breeds of dogs known to be at risk for specific neoplasms were examined. At least 4 of 5 immature dogs with osteogenic sarcoma were large-breed dogs, and 2 of 4 immature dogs with intranasal neoplasms had dolichocephalic skull conformation.

Discussion

Several confounding factors should be accounted for in interpreting the study. A true sampling of the canine population to develop estimates of risk for neoplasia is difficult to accomplish, especially for neonates. Most young dogs with neoplasms probably die without veterinary involvement. The VMDP represents only referred animals, and may not represent the true spectrum of tumors seen in private practice. Finally, coding of data was not validated, thus coding errors could affect the results of this study. Estimates of risk were based on our study population of dogs that all had neoplasia, and, thus, reflect proportional morbidity.

The brain and hematopoietic system are sites of high risk for cancer in human infants.[1,2,6,b] Of the 74 neoplasms identified in immature dogs of our study, 15 were from the hematopoietic system. It is known that risk for malignant lymphoma increases with age. The age-specific incidence for dogs <1 year old was estimated at 1.5/100,000 dogs/yr, with an increase to 84/100,000 in the 10- to 11-year-old group.[7] According to our data in dogs, the risk for lymphoma was greater in dogs ≤6 months old than dogs >6 months old. Thus, a bimodal peak for lymphoma in dogs may exist that is analogous with the bimodal peaks in human beings for 2 hematopoietic tumors, namely acute lymphocytic leukemia and Hodgkin's disease.[8] Specific causes or risk factors have not been identified for hematopoietic neoplasms in immature dogs, but cellular transmission of malignant lymphoma has been accomplished experimentally in irradiated and nonirradiated neonates, which may indicate that it is infectious.[9-12] Genetic factors may influence the risk for malignant lymphoma in

Site	No.
Hematopoietic system	15
Lymphoma (12)	
Lymphoid Leukemia (1)	
Granulocytic leukemia (1)	
Multiple myeloma (1)	
Brain	11
Meningioma (4)	
Glioma (2)	
Hamartoma (1)	
Lipoma (1)	
Astrocytoma (1)	
Ependymoma (1)	
Choroid plexus papilloma (1)	
Skin	8
Mastocytoma (3)	
Papilloma (1)	
Melanoma (1)	
Histiocytoma (1)	
Hamartoma (1)	
Lymphangiosarcoma (1)	
Endocrine System	6
Pancreatic islet cell carcinoma (5)	
Pheochromocytoma (1)	
Bone	6
Osteosarcoma (5)	
Osteoma (1)	
Oral Cavity	5
Ameloblastoma (1)	
Basal cell carcinoma (1)	
Melanoma (1)	
Papillomatosis (1)	
Squamous cell carcinoma (1)	
Genitourinary tract	5
Bladder transitional cell carcinoma (1)	
Nephroblastoma (1)	
Transmissible venereal tumor (1)	
Testicular seminoma (1)	
Interstitial cell tumor (1)	
Nasal Cavity	4
Squamous cell carcinoma (2)	
Adenocarcinoma (1)	
Chondrosarcoma (1)	
Respiratory Tract	4
Adenocarcinoma (3)	
Chondrosarcoma (1)	
Miscellaneous	10
Leiomyosarcoma intestinal (1)	
Nodular ganglioneuroma (1)	
Sarcoma (1)	
Fibroma spinal cord (1)	
Hemangiosarcoma (6)	
Total tumors	74

Figure 1—Sites and frequencies of 74 neoplasms in 69 dogs <6 months old (data collected from March 1964 to June 1989).

Table 1—Odds ratios, with 95% confidence intervals, for site of neoplasm for immature vs mature dogs from data collected between Feb 28, 1964 and July 1, 1977.

Tumor site	Immature dogs	Mature dogs*	Odds ratio	95% Confidence interval
Brain	5	339	10.9	[4.1 to 28.9]†
Hematopoietic system	8	1,907	3.3	[1.4 to 7.4]†
Respiratory tract	1	235	2.7	[0.4 to 20.0]
Endocrine system	2	725	1.8	[0.4 to 7.5]
Oral cavity	2	1,108	1.1	[0.3 to 4.8]
Genitourinary tract	2	1,542	0.8	[0.2 to 3.3]
Bone	1	1,119	0.5	[0.1 to 4.1]
Skin	3	3,572	0.5	[0.1 to 1.5]
Miscellaneous	4	6,860	NA	NA
Total	28	17,407	NA	NA

*Data from Priester et al.[4] †Indicates significance ($P = 0.05$).
NA = Not available.

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[b] Barson AJ. Congenital neoplasia: the society's experience (abstr). *Arch Dis Child* 1978;54:436.

dogs because a high risk for this neoplasm had been identified in some families of English Bullmastiffs.[13]

In our study, the second most frequently recognized site for neoplasia was the brain (n = 11). In human beings, brain tumors constitute the most common type of solid malignancy in children[14] whereas dogs have increased risk with age for all nervous-system tumors.[15] Some perinatal events can induce neoplasia of the CNS in dogs. Intracranial gliomas and sarcomas have been induced in puppies within several weeks of in utero injection with Rous sarcoma virus,[16] and exposure to radiation perinatally has been associated with an astrocytoma in a 3-month-old dog.[17]

Osteogenic sarcomas were found primarily in large-breed dogs, and half of the immature dogs with intranasal neoplasms had dolichocephalic skull conformation. These data were consistent with other studies.[18,19] Other breed and tumor associations were not found, possibly because of the small sample size, or because the factors that influenced risk for neoplasia within a specific breed of dog are not manifested until late in life.

The similarities of sites affected with neoplasms between the human infant and the immature dog may indicate a susceptibility of these tissues to carcinogenic influences in the perinatal period. Dogs closely share our environment, and perhaps neoplasms derived from the brain or hematopoietic tissues in immature dogs are influenced by the same events that influence development of neoplasms in human beings.

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A3100-2

June 15, 1992, Volume 200, Number 12

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

Azure

Jerry W. Norris

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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JAVMA 200 (12) 1765-2044
ISSN 0003-1488

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About the cover

Jerry W. Norris is known as the "Dotman" because he paints in the style of pointillism. At the time *Azure* was submitted for consideration, Mr. Norris was an animal groomer at a veterinary clinic in Independence, Mo. where his wife is currently a veterinary technician.

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SUBSCRIPTIONS: For one year: members $50; others $100 in the United States and possessions; $120 in foreign countries. Single copies: $6 in the United States and possessions; $8 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

ADDRESS CHANGE: Send new address (and moving date) 45 days ahead. Include old address as it appeared on previous issues (if possible send label).

POSTMASTER: Send address changes to JAVMA, 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360.

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Special Report

Follow-up study of owner attitudes toward home care of paraplegic dogs

Michael Bauer, DVM; Nita Glickman, MS, MPH; Larry Glickman, MPH, VMD;
James Toombs, DVM, MS; Scott Golden; Cindy Skowronek

Summary: *A questionnaire was mailed to 30 owners of paraplegic dogs who had been caring for their dogs at home for 3 to 72 months. It was designed to collect information on demographic variables, duration of ownership and paralysis, age of the pet, pet/owner relationship, owner expectations and perceptions of the pet's quality of life, problems the pet experienced, effect that maintaining a paralyzed pet had on the owners' quality of life, and whether use of a cart was beneficial.*

Significant correlation was found between prior expectations that the pet would lead a high-quality life and perception that the pet, in fact, had a high quality of life during paralysis ($r^2 = 0.61$, $P = 0.01$). Owners who had anticipated that extra work would be necessary to care for their paraplegic dog had a more positive attitude toward home care ($r^2 = 0.55$, $P = 0.03$).

Overall, owners involved in the study were satisfied with all aspects of maintaining paraplegic dogs at home. Our findings support the feasibility of dedicated owners successfully maintaining small (average body weight, 9 kg) paraplegic dogs at home for extended periods.

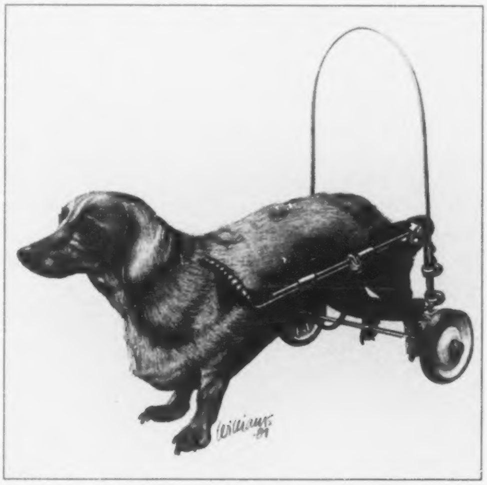

Figure 1—The K-9 cart used to help paraplegic dogs ambulate.

Paraplegia attributable to intervertebral disk herniation or other forms of spinal cord trauma is a common problem in dogs.[1] Dogs with permanent paralysis or those convalescing may be maintained at home for extended periods despite complications, including urinary tract infection, decubital ulcers, and fecal and urinary incontinence. However, such pets may lead what is perceived to be a good-quality life by their owners. Furthermore, adverse effects on the owners' own quality of life may be minimal and "worth the effort involved." The purpose of the study reported here was to evaluate results of a questionnaire mailed to individuals who owned and cared for a paraplegic dog at home for a minimum of 3 months.

Materials and Methods

Participants—All dog owners in this study were participants in a Purdue University School of Veterinary Medicine (PUSVM), Center for Paralysis Research (CPR), prospective clinical trial investigating various treatment modalities for complete hind-limb paralysis. The CPR program accepted deep pain response-negative, paraplegic dogs with focal traumatic lesions or disk herniations between the second thoracic and fourth lumbar vertebrae. All dogs had been examined previously by a referring veterinarian. The primary treatment modalities in the CPR program involved standard medical and surgical treatment, as well as surgical implantation of an oscillating field electrical stimulator in hopes of initiating axonal regeneration. Owners were given the details of the program, and were told that, despite our efforts,

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From the Center for Paralysis Research (Bauer, Toombs, Golden, Skowronek), Department of Veterinary Clinical Sciences (Bauer, Toombs), Center for Applied Ethology and Human-Animal Interaction (N. Glickman) and Department of Veterinary Pathology (L. Glickman), School of Veterinary Medicine, Purdue University, West Lafayette, IN 47907-7403.

Dr. Bauer's present address is Department of Clinical Sciences, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO 80523.

[a] K-9 Cart, K-9 Cart Co, Berwyn, Pa.

prognosis for recovery was poor but not hopeless. Dogs were accepted into the CPR project with the understanding that the program would pay all medical expenses if the owner agreed to maintain their pet at home for at least 6 months, even if treatment was unsuccessful. All dogs were kept mainly inside, although this was not a criterion for inclusion in the CPR study. Owners were supplied with a cart[a] to aid in their dog's ambulation (Fig 1). The cart was designed to provide wheels under the caudal portion of the dog. Owners were encouraged to use the cart while supervision was possible and simply confine their pets during nonsupervised periods.

All participants in the CPR program who had owned and maintained a paraplegic dog weighing < 15 kg for at least a 3-month duration ($n = 30$ individuals) were mailed questionnaires. Questions were personalized to include the specific pet's name and gender, rather than using a generic type format. Questions and statements were designed to measure attitudes on a 5-point Likert scale: agree strongly, agree, neutral, disagree, or disagree strongly (Appendix).[2]

Interpretation of questionnaire—Selected questions were chosen to generate composite scores for each respondent regarding the pet-owner relationship, the owners' perceptions about the pet's quality of life, the pet's problems, and the work required to maintain the pet. For example, relationship score was established by use of questions 4–8, with higher score indicating increased "closeness" between owner and pet (maximal score = 25). The pet/owner relationship questions were adopted from a previous study on pet-owner attachment.[3] Perception score was generated by use of questions 11, 12, and 23–27, with higher score indicating favorable perceptions regarding the pet's quality of life (maximal score = 35). Pet problem score was determined by questions 18, 26, 28, and 29, with higher score indicating increased problems experienced by the pet (maximal score = 20). Work score was established by use of questions 13 and 17, with higher score indicating increased amount of work necessary by the owner to maintain their pet (maximal score = 10).

Statistical methods—Fifteen hypotheses were generated regarding associations between the age of the pet and the four composite scores (pet/owner relationship, owner perceptions about the pet's quality of life, pet's problems, and work required to maintain the pet), and associations between the composite scores themselves. These hypotheses were tested, using Pearson's correlation coefficients.[4]

A *t* test was used to compare duration of dog ownership (< 2 years vs ≥ 2 years) with the four composite scores.[4] The *t* tests were also used to compare the four composite scores with the following demographic variables: live in city vs country; live in house vs apartment; whether or not the family had children < 18 years old living at home; whether or not the house had a large yard; gender of the pet's primary caretaker; and whether or not the primary caretaker worked outside the home.

Analysis of variance was used to determine whether association existed between owner age (< 30, 30 to 49, and ≥ 50 years) and composite scores.[4] A P value of < 0.05 was considered statistically significant. When multiple comparisons were made, the Bonferroni method was used to determine the significance level of the P value.

Results

Of the 30 questionnaires mailed to owners, 27 (90%) questionnaires were completed and returned. Demographic characteristics of the primary caretakers were determined (Table 1). Information regarding age of the dog and duration of ownership, pet/owner relationship, owner expectations and perception of the pet's well-being, and benefit of a cart were tabulated (Appendix). Composite scores with regard to pet/owner relationship, the owner perceptions of their pet's quality of life, pet's problems, and the work required to maintain the pet also were categorized (Table 2).

Demographic data—On the basis of demographic characteristics, statistically significant differences were not evident between owner relationship with their dog, owner perception of their dog's well-being, dog's problems, work involved with maintaining the pet, or owner's own quality of life.

Duration of ownership and age of the dog—Age of the dog at the onset of paralysis ranged from 3 to 102 months, with median of 52 months. The number of months dogs were owned prior to paralysis ranged from 0 to 100 months, with median of 48 months. One dog had been adopted after paralysis; this was recorded as 0 months of ownership prior to paralysis. Duration of ownership after paralysis ranged from 3 to 72 months, with median of 20 months. Statistically significant correlations were not found when age of the dogs and duration of ownership before and after paralysis were compared with pet/owner relationship, owner perceptions of the dog's quality of life, problems the dogs experienced, work involved with maintaining the dogs, and whether the owner's own quality of life was affected.

Relationship scores ranged from 13 to 25 ($\bar{X} = 20$, SD 3.0). Ninety-six percent of the owners agreed strongly or agreed that they talked to their pet as they would to a child. All agreed strongly or agreed they were aware of their pet's moods, and 85% believed the pet was aware of the owner's moods.

Expectations—Sixty-one percent agreed strongly or agreed that they expected their pet would lead

Table 1—Demographic characteristics of primary caretakers of paralyzed pets

Variable	Category	Percentage of owners
Age	20 to 29	21
	30 to 39	16
	40 to 49	26
	50 to 59	16
	60 +	21
Gender	F	68
	M	16
	Both were primary caretakers	16
Work outside the home	Yes	63
	No	37
Child < 18 years old at home	Yes	16
	No	84
Type of residence	House	90
	Apartment	10
Marital status	Married/living with companion	74
	Live alone	26
Area of residence	City	68
	Rural	32
Residence has large yard	Yes	68
	No	32

Table 2—Scores generated regarding pet-owner relationship, owner perceptions about the pet's quality of life, pet's problems, and work required. Higher scores correspond to a closer relationship, better perception about the pet's quality of life, more pet problems, and more work, respectively

Variable	Questions	Maximal possible score	Range	Mean	Standard deviation
Relationship score	4–8	25	13 to 25	20	3.0
Perception of pet's quality of life score	11, 12, 23–27	35	20 to 35	27.7	4.2
Pet problem score	18, 26, 28, 29	20	4 to 15	9.6	3.2
Work score	13, 17	10	2 to 8	3.4	1.6

a good-quality life after paralysis. Forty percent agreed strongly or agreed that they expected their pet would recover. All respondents agreed strongly or agreed that they expected increased work to maintain their pet should it remain paralyzed. Statistically significant correlation existed ($r^2 = 0.61$; $P = 0.01$) between expectations that the pet would lead a high-quality life and the perception that the pet did lead a high-quality life during paralysis. Statistically significant correlation ($r^2 = 0.55$; $P = 0.00$) was also found between owners' anticipation that extra work would be necessary to care for their paraplegic dog and the perception that their pet was leading a high-quality life.

Owner perceptions of the pet's quality of life—The pet's quality of life was assessed by comparing owner responses to questions about their perceptions of the pet's quality of life and pet problems, such as decubital ulcers and urinary tract infection (UTI). A perception score was generated as previously described. Higher perception score indicated more favorable outlook regarding the pet's well-being.

Scores ranged from 20 to 35 ($\bar{X} = 27.69 \pm 4.2$). All owners disagreed or disagreed strongly that their pet was leading a poor-quality life. Eighty-five percent believed that their pet's attitude was as good as before surgery, and 74% believed that their pet did not realize it was paralyzed.

Pet problems—The frequency of problems experienced by paralyzed dogs was evaluated, using responses to questions related to UTI, decubital ulcers, and urination and defecation in the house. Ninety-four percent of the respondents said UTI were not a problem or were infrequent (<1/mo). Seven percent of the owners agreed strongly and 19% agreed that decubital ulcers were a problem. Seventy percent of owners said urination in the house and 63% said defecation in the house was observed once a week or less. Pet problem score ranged from 4 to 15 ($\bar{X} = 9.6 \pm 3.2$).

Owner's quality of life—Work scores ranged from 2 to 8 ($\bar{X} = 3.44 \pm 1.8$). Eighty-nine percent of the owners disagreed or disagreed strongly that the work was excessive, and 85% disagreed or disagreed strongly that the work lowered their own quality of life. Ninety-four percent agreed or agreed strongly that the work was worth the effort, and 37% agreed strongly or agreed that the work brought their family closer together. Significant correlation ($r^3 = 0.89$; $P = 0.01$) was found between owners with higher work scores and those who believed their own quality of life was lowered by maintaining a paralyzed pet.

Cart use—Most owners believed that use of a cart was important for maintaining their pet. Eighty-two percent agreed strongly or agreed the cart was beneficial, and 92% agreed strongly or agreed that they would recommend a cart to other owners who decided to maintain a paralyzed pet.

Overall, owners were satisfied with their decision to maintain their pet as a paraplegic. Eighty-five percent agreed strongly or agreed that if they had the decision to make over again they would choose to care for their pet rather than choose euthanasia.

Discussion

Our study dealt with a select group of clients admitting their dogs to a referral center. Undoubtedly, numerous potential participants were eliminated prior to reaching Purdue University. Furthermore, some were eliminated or declined admission into the CPR program after discussing the project with a clinician at Purdue. The final group of owners admitting their dog into the CPR program were dedicated, informed owners who voluntarily made the decision to maintain their pet as a paraplegic.

The percentage of responses was higher than might be expected from a written questionnaire returned by mail. The most logical explanation is the bond established between Purdue's paralysis research team and the owner. Another factor may have been the personalized format of the questionnaire. This format made statements and asked questions by using the pet's name and gender instead of "your dog" and "it."

We anticipated that demographic factors would significantly influence questionnaire responses. For example, we believed the ideal situation would involve someone without children, who did not work, and who lived in a house with a large yard. However, significant differences were not found between any aspect of our study and demographic characteristics. These results indicate that home care of small paraplegic dogs over extended periods may be feasible regardless of the age or gender of the owner or the physical setting in which the client and dog live. This may reflect the desire, commitment, and caring of the clients of this study. However, if we had included larger dogs and a larger number of owners, demographic characteristics may have become significant.

Age of the dog and duration of ownership before and after paralysis did not have significant effect on owners' responses. It seems reasonable to speculate that clients who had owned their dogs for longer periods would have developed a closer relationship. However, on the basis of pet/owner relationship questions, all owners in this study had a strong attachment to their dogs, regardless of duration of ownership. This may reflect the nature of the clients included in our study. Such individuals may have a caring attitude toward animals, especially those with physical disabilities, which allowed development of a close relationship independent of duration of ownership.

The minimal duration that owners had cared for their paraplegic dogs before being included in this study was arbitrarily set at 3 months. It seems possible that as more time elapsed, an owner might become discouraged or overwhelmed while taking care of a paraplegic dog. We did not find evidence for this speculation in our study. In fact, most owners developed a closer bond with their dog after their dog was paralyzed. Whether or not home care of paraplegic dogs for several years' duration would lead to owner frustrations and discouragement is difficult to say, because the number of such caretakers in our study was not large enough for statistical analysis.

We included questions with regard to the pet-owner relationship to determine whether various degrees of "closeness" influenced owner perceptions about home care of paraplegic dogs. However, most clients in our study felt extremely close to their dog, as indicated by the fact that 96% of them talked to their dog as though it were a child. On the basis of selection criteria and procedures for admitting a dog into the CPR program, it was not surprising that most owners in this study had an emotional attachment or close relationship with their dog. The relationship score did not have significant effect on other composite scores (ie, owner's perception, pet problem, and work scores). If a more generalized population of pet owners, with wider distribution of relationship responses and scores had been involved, it is more likely that the pet/owner relationship might have directly influenced responses in other categories.

Owners who were optimistic about their dog's quality of life and those who anticipated extra work responded most favorably regarding their perceptions of the dogs' well-being after paralysis. This indicates that owner expectations may be as important as the dogs' actual existence after paralysis. Furthermore, the fact that owners who anticipated more work responded more favorably illustrates the importance of veterinarian-client communication regarding the daily tasks necessary for home care of paraplegic dogs. Owner expectations may be useful in helping owners decide whether to euthanatize or keep a paraplegic pet.

Owner perceptions of their pet's quality of life was overwhelmingly positive. In fact, most believed their pet's quality of life, activity level, and attitude were as good as they were before paralysis. No owner believed that their pet was leading a poor-quality life. We believe such responses are valid, and are accurate reflections of the pet's well-being. Many of these owners had cared for their dogs for extended periods and, through such dedicated caretaking, had closely observed their dog's behavior. Reasons for these positive responses may be attributable to numerous factors. Again, a select population of clients participated in our study, most of which were closely attached to their dogs. Furthermore, prior to entering the CPR study, we informed clients that their dogs could lead a good-quality life even if treatment was unsuccessful. We also clearly and completely explained the daily maintenance their paraplegic dogs would require. Our optimistic approach may have influenced owner expectations and decisions to maintain their dog. However, owners were encouraged to give careful consideration to the decision at hand because they were committing to a 6-month contract. In no way, do we believe we pressured any owners into entering the CPR study.

Owners that entered the CPR study were offered continual support, advice, and medical assistance. We frequently adjusted carts, treated UTI, explained how to protect abraded areas, and suggested how diapers could be modified to control urinary incontinence. Our study illustrates the importance of owner attitude and anticipation of work required. We believe veterinarians should have a vital, yet unbiased role in advising and supporting clients.

Medical disorders secondary to paralysis are common in human beings.[5] In fact, UTI leading to major medical problems are common in people with quadriplegia or paraplegia.[5] We anticipated a higher frequency of secondary problems in our study than was found. Most owners said UTI were not a problem. It is possible and even probable that our figures underestimated UTI frequency because owners, not veterinarians, were responding to the questionnaire. However, owners involved in this study were well informed and educated with regard to clinical signs of UTI, and became experienced at making such observations. Furthermore, dogs in this study did not develop any life-threatening problems that would be expected if UTI were not brought to the attention of a veterinarian and treated. Properly trained owners can become proficient at expressing the dog's urinary bladder, which may explain the low number of related problems in our study. Furthermore, some paraplegic dogs in this study developed some form of nonassisted micturition. Currently, the CPR program has followed a total of 78 dogs, 30 of which were included in this study; of those dogs, only one developed a life-threatening urinary tract-related problem.

Twenty-six percent of the owners believed that decubital ulcers were a problem. In most instances, the ulcers developed from the cart rubbing the inner portion of the dog's thighs or on the dorsum of the metatarsal or phalangeal areas because of dragging. Most of these problems were successfully managed by cart adjustments or by protecting the ulcerated areas with padding (ie, gauze and tape, cotton socks). Two dogs developed ulcers that required surgical debridement. In both instances, the wounds healed successfully by second intention. No dog required any type of reconstructive surgery. No owner reported additional problems when asked for additional comments about their pet.

Euthanasia is almost certainly the most common cause of death in paraplegic pets. The decision to euthanatize a paraplegic pet is undoubtedly related to numerous factors. We believe that the anticipation or occurrence of soilage attributable to urination or defecation in the home would probably have a major role in the euthanasia decision. Therefore, we included these problems with "pet problems." Most owners reported such problems infrequently. These problems were often managed by using a modified diaper. Urination was more satisfactorily managed this way than was defecation.

The tolerance for fecal and urinary incontinence undoubtedly varies among owners. However, only one owner in this study euthanatized their dog. In this case, fecal incontinence along with the extra work needed to care for the dog, led to the decision for euthanasia. The surprisingly low number of owners who found urinary or fecal incontinence to be a problem may have been affected by two factors. As previously mentioned, some dogs resumed some form of nonassisted micturition. Another important point is that all dogs in our study had upper motor neuron injuries (ie, the lumbosacral plexus was intact). Therefore, most dogs had problems with the emptying, not the storage phase of micturition, and anal tone was present. Animals with injuries resulting in constant urine dribbling and flaccid anal tone may represent a greater problem.

Caring for a paraplegic dog entails additional work and problems that may affect the owner's life style or quality of life. We tried to examine this aspect of maintaining a paralyzed pet by generating a work score and by asking owners to respond to questions and statements pertaining to their own quality of life. Our results indicate that caring for a paraplegic pet may have little or no adverse effect on the owner's quality of life. In fact, 37% of the respondents believed such efforts had brought their family closer together. The select clients who participated in our study probably had an effect on the overall positive nature of these responses. The work required to maintain a paraplegic dog is certainly not suitable to all pet owners. Once again, veterinarians should explain to clients the effort required to maintain such dogs. Through realistic explanations, owners can be aided in making the critical decision to maintain or euthanatize their dogs.

In our experience, the use of a cart has allowed paraplegic animals to ambulate well. Small dogs, as in this study, quickly learn and adjust to the use of wheels instead of hind limbs. Our beliefs were reconfirmed by this study. By far, most owners believed use of a cart had an important role in maintaining their pet.

Results of this study support the belief that small paraplegic dogs lead a good-quality life if given appropriate home care. The most significant factor influencing owner perceptions of dog's well-being is initial owner expectations. This emphasizes the veterinarians' role in client communication. Owners of small paraplegic dogs should be made aware of these findings and informed of the home care required. Most informed owners who decide to provide home care for their paraplegic dogs for extended periods will be pleased with their dog's quality of life, as well as changes in their own life.

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Appendix

Questions asked and responses obtained from the questionnaire

Paralysis Questionnaire

	Mean ± SD
1) Age of "Name" at time of paralysis.	52.5 ± 20.3 mo
2) Duration of ownership prior to paralysis.	48.0 ± 25.3 mo
3) Duration of ownership since paralysis.	20.3 ± 16.0 mo

Your relationship with *(name)*

QUESTION OR STATEMENT	Agree strongly (%)	Agree (%)	Neutral (%)	Disagree (%)	Disagree strongly (%)
4) I talk to "Name" as I would to a child.	51.9	44.4	00.0	3.7	00.0
5) I confide in "Name" (talk to "gender" about problems or events that are important to me).	22.2	25.9	33.3	18.5	00.0
6) I think that I am aware of "Name's" moods.	48.1	51.9	00.0	00.0	00.0
7) I think "Name" is aware of my moods.	29.6	55.6	14.8	00.0	00.0
8) I feel closer to "Name" than to my friends or family members.	11.1	44.4	22.2	18.5	3.7

Your expectations

QUESTION OR STATEMENT	Agree strongly (%)	Agree (%)	Neutral (%)	Disagree (%)	Disagree strongly (%)
9) Prior to entering the CPR project I was optimistic "Name" would lead a quality life if "gender" remained paralyzed.	22.2	37.0	14.8	14.8	11.1
10) I expected that an increased amount of work would be required to maintain "Name" as a paralyzed pet.	44.4	55.5	00.0	00.0	00.0

Your experiences and feelings since surgery

QUESTION OR STATEMENT	Agree strongly (%)	Agree (%)	Neutral (%)	Disagree (%)	Disagree strongly (%)
11) "Name" is leading an unacceptably poor quality of life.	00.0	00.0	00.0	48.1	51.9
12) "Name" 's quality of life is as good as before surgery.	29.6	37.0	11.0	22.0	00.0
13) The work associated with maintaining "Name" as a paralyzed pet is just too much for me and for my family.	7.4	3.7	37.0	51.9	00.0
14) The work associated with maintaining "Name" as a paralyzed pet is worth the effort.	77.8	18.5	3.7	51.9	00.0

	Agree strongly (%)	Agree (%)	Neutral (%)	Disagree (%)	Disagree strongly (%)	Not apply (%)
15) The work associated with maintaining "Name" as a paralyzed pet has brought me closer to "gender".	56.0	32.0	2.0	00.0	00.0	00.0
16) The work associated with maintaining "Name" as a paralyzed pet has brought our family closer together.	14.8	22.2	25.9	22.2	00.0	14.8

	Agree strongly (%)	Agree (%)	Neutral (%)	Disagree (%)	Disagree strongly (%)
17) The work associated with maintaining "Name" as a paralyzed pet has altered my daily routine to the point where it has lowered my own quality of life.	00.0	7.4	7.4	40.7	44.4

	Very frequently (at least 2 times a day) (%)	Frequently (1 time a day) (%)	Infrequently (1 time a week) (%)	Very frequently (less than 1 time per week) (%)	Does not occur (%)
18) Soilage (due to urination) in the house occurs	14.8	14.8	18.5	18.5	33.3
19) Soilage (due to defecation) in the house occurs	22.2	14.8	33.3	14.8	14.8

QUESTION OR STATEMENT	Agree strongly (%)	Agree (%)	Neutral (%)	Disagree (%)	Disagree strongly (%)	Not a problem (%)
20) Soilage (due to urination) in the house has been effectively managed by using a modified diaper.	14.8	11.1	11.1	7.4	7.4	48.1
21) Soilage (due to defecation) in the house has been effectively managed by using a modified diaper.	11.1	7.4	14.8	11.1	11.1	44.4

	Agree strongly (%)	Agree (%)	Neutral (%)	Disagree (%)	Disagree strongly (%)
22) If I had to make the decision over again, I would maintain "Name" as a paralyzed pet instead of euthanatizing "gender."	74.1	14.8	3.7	00.0	7.4

"Name"

QUESTION OR STATEMENT	Agree strongly (%)	Agree (%)	Neutral (%)	Disagree (%)	Disagree strongly (%)
23) "Name" 's attitude appears greatly depressed compared to before paralysis.	00.0	00.0	11.5	42.3	46.2
24) "Name" 's attitude appears as good as before paralysis.	38.5	46.2	7.7	7.7	00.0
25) "Name" 's activity level is greatly depressed compared to before paralysis.	3.8	19.2	3.8	57.7	15.4
26) "Name" 's activity level is as good as before paralysis.	7.7	50.0	11.5	26.9	3.8
27) "Name" does not realize "gender" is handicapped.	37.0	37.0	7.4	18.5	00.0
28) Decubital ulcers (sores due to lack of feeling in the limbs) are a problem.	7.4	18.5	14.8	33.3	25.9

QUESTION OR STATEMENT	Constantly (%)	Frequently (1-2 times per month) (%)	Infrequently (1 time per month) (%)	Very infrequently (less than once per month) (%)	Not a problem (%)
29) Urinary tract infections (bloody urine) occur.	00.0	00.0	7.4	33.3	59.3

	Cart				
QUESTION OR STATEMENT	Agree strongly (%)	Agree (%)	Neutral (%)	Disagree (%)	Disagree strongly (%)
30) The cart is definitely a benefit to "Name."	52.2	3.04	8.7	8.7	00.0
31) "Name" 's adjustment to life in a cart was easy and quick.	47.8	26.1	4.3	21.7	00.0
32) Without the cart maintaining "Name" as a paralyzed pet would be unacceptable.	17.4	8.7	13.0	43.5	17.4

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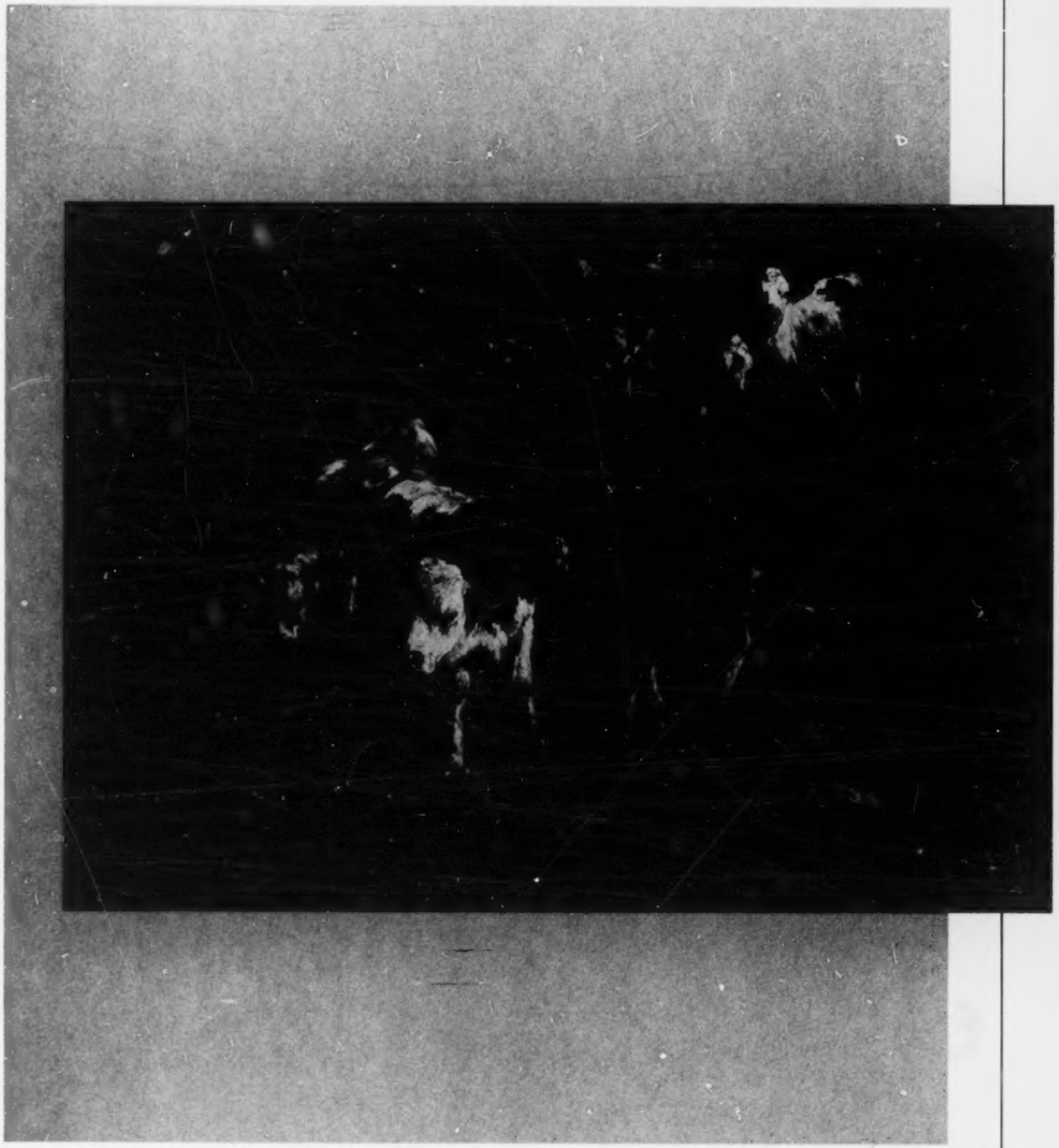

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 201 July 1, 1992 No. 1
JAVMA 201 (1) 1-192 (1992)
ISSN 0003-1488

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SUBSCRIPTIONS: For one year: members $50; others $100 in the United States and possessions; $120 in foreign countries. Single copies: $6 in the United States and possessions; $8 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

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BPA

Survey measures technician activities

The North American Veterinary Technician Association (NAVTA), founded to represent and support veterinary technicians, received a grant from Hill's Pet Products, Inc, to conduct a national survey assessing the demographics and current opinions of the veterinary technology profession. A questionnaire was developed and distributed, and data were tabulated with the assistance of Dr. Karl Wise of the AVMA Center for Information Management.

For the purpose of this study, a veterinary technician was defined as a graduate of an AVMA–accredited program or someone who is credentialed by his/her state through examination as a certified, licensed, or registered veterinary technician.

The survey was distributed to 3,450 persons within these three groups. Group One, identified as members, comprised 1,198, 1991 NAVTA members. Group Two, identified as nonrenewals, comprised 266, 1990 NAVTA members who did not renew in 1991. Group Three, identified as nonmembers, was made of randomly selected subscribers to *Veterinary Technician*. The response rate to the survey was 47%.

To assess the profile, the three target groups were evaluated on the basis of gender, age, and duration of employment. Of the 1,616 respondents, 95% were female, with a mean age of 31. The average duration of employment as a veterinary technician was seven years. Respondents worked for an average of two employers since beginning their career and indicated they worked approximately 40 hours per week.

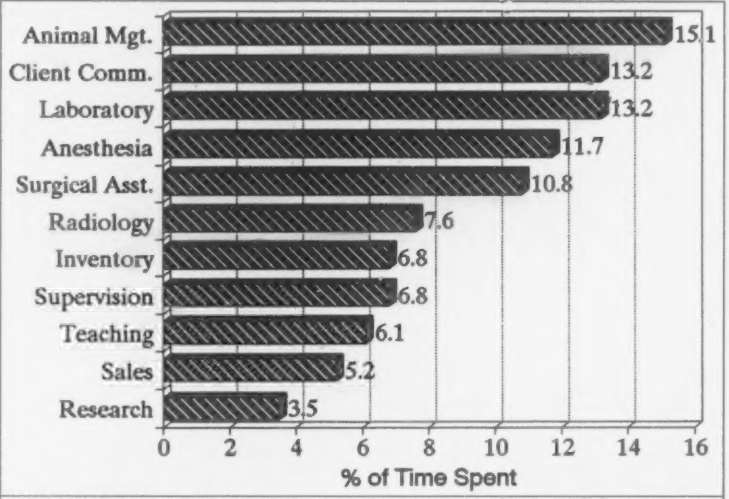
The data indicated that the majority of respondents work in the Northeast (30%) and Midwest (30.5) regions. Eighteen percent of respondents were from the South region and 21.5% hail from the West.

Respondents were asked to indicate the size of their community and practice type. The following information indicates distribution according to community size:

Rural area (population < 2,500)	5.4%
Small community (population 2,500-50,000)	34.0%
Moderate urban area (population 50,001-500,000)	37.3%
Large urban area (population > 500,001)	23.3%

Fifty percent of all respondents indicated that they are employed in companion animal practice, 16% in mixed animal practice, with an even distribution of less than 6% in each of 12 other categories.

The respondents who work in private practice indicated that there were an average of three veterinarians, two veterinary technicians, and three other assistants on staff where they were employed. In another question, 66% of respondents indicated that the computer played a role in the practice, with 80% using the computer for client records, 46% for inventory, 40% for word processing, and 28% for data analysis.



According to the NAVTA survey, technicians spend more time in animal management than in any other task.

Respondents then were asked to estimate the percentage of their day spent in the performance of 11 tasks. The data indicate that a majority of the respondent's time is spent in the areas of animal management, client communications, and laboratory procedures.

To identify changes in the time allocated to perform these tasks, respondents were asked: What activity takes up more of your time on the job today than it did three years ago? Twenty-one percent of the respondents indicated that client communications takes up more of their time on the job than it did three years ago. Fourteen percent indicated that more of their time is allocated to perform inventory/ordering tasks, 13% for supervision of staff, and 10% for laboratory activities, when compared with three years ago. These data suggest that, as the veterinary technology profession matures, the veterinarian is delegating more of the practice management tasks to the technician. They also indicate that practice management is an avenue of career advancement for the veterinary technician in private practice.

Written by A. Patrick Navarre, RVT, a veterinary technology instructor and operating room supervisor in the Large Animal Clinic at Purdue University in West Lafayette, Ind, and Carlene Decker, CVT, a veterinary technology instructor at Parkland College in Champaign, Ill. They are the NAVTA Task Force members responsible for implementing the grant from Hill's to conduct the national survey.

Description and evaluation of the influence of veterinary presence on the use of antibiotics and sulfonamides in dairy herds

John B. Kaneene, DVM, MPH, PhD, and RoseAnn Miller, BS

Summary: *A longitudinal study was conducted over 2 years to identify types of antibiotics and sulfonamides used in Michigan dairy herds for disease prevention and treatment, to determine patterns of use of antibiotics and sulfonamides by herd size and animal age group, and to determine the influence of veterinary presence during diagnosis on the types of antimicrobials used for disease treatments.*

In order of frequency, the most commonly used preventive antibiotic and sulfonamides were penicillins, tetracyclines, aminoglycosides, and cephalosporins, making up over 86% of all antimicrobials used for disease prevention. The most commonly used therapeutic antibiotics and sulfonamides were penicillins, tetracyclines, aminoglycosides, and sulfonamides, making up over 81% of all antimicrobial drugs used for disease treatment. Cows received the greatest number of drugs, followed by calves (cattle from birth to weaning). Young stock (cattle from weaning to first calving) received the lowest number of drugs. All herds had similar patterns of drug use for the 3 age groups, regardless of herd size.

With the exception of polymyxin and chloramphenicol, producers used antibiotics on their own more than with a veterinarian present or on the advice of a veterinarian. Overall, veterinary presence was significantly associated with increased use of tetracyclines, sulfonamides, and nitrofurans, and decreased use of penicillins and aminoglycosides. Implications for drug residue prevention strategies are discussed, with emphasis on the role of the practicing veterinarian.

The use of antimicrobial drugs in modern dairy farms is common. These products are used in high doses to treat sick animals, lower doses to prevent disease, and in subtherapeutic doses to improve growth and feed efficiency.[1] It has been estimated that 75% of all dairy calves marketed in the United States have received antibiotics at some time in their lives.[2] With the potential for human health hazards from residues, the use of antimicrobials in food animals is of concern to consumers and producers.[3-8] Similarly, the potential for economic damage from residues to the milk processing industry is a major concern.[3,5] Recent studies have found detectable residues in 63% of milk sampled from store shelves in the northeastern United States,[3] whereas residues rates of 33% were found in the western United States.[9] In a recent survey,[3] the most commonly found antimicrobial drugs in milk were sulfonamides and tetracyclines, and, in another study,[4] sulfonamides, penicillins, aminoglycosides, cephalosporins, and chloramphenicol were the most commonly found. Practices that contribute to residues in milk include the use of feed additives,[3,4,6,7,10] producers not following withholding times,[4,7,10-12] misuse of drugs,[7] use of temporary labor at the farm,[10] and poor animal records and identification.[10,12] The use of antimicrobial drugs to control mastitis is considered to be one of the primary sources of residues in milk.[3,4,11]

Livestock producers and the professionals that serve the industry will have to work together to meet the growing demand for higher standards of food safety from consumers. One of the areas of interdisciplinary cooperation should be in the documentation of types of drugs that are used on farms, and the circumstances under which they are used. Information that identifies how these drugs are being used can be helpful to pinpoint specific practices that lead to residue problems.

The objectives of the study reported here were to identify types of antibiotics and sulfonamides most commonly used in Michigan dairy herds for disease prevention and treatment, to determine patterns of use of antibiotics and sulfonamides by herd size and age group, and to determine the influence of veterinary presence during diagnosis on the types of antimicrobials used for disease treatments.

From the Population Center, College of Veterinary Medicine, Michigan State University, East Lansing, MI 48824-1316.

Supported in part by USDA-APHIS-VS Cooperative Agreement No. 12-16-93-229 and Michigan State University College of Veterinary Medicine.

The authors thank the veterinary medical officers of the Michigan Department of Agriculture, USDA-APHIS-VS, and Michigan State University for their essential role in collecting the data; and veterinary practitioners for providing information on disease diagnoses and treatments.

Materials and Methods

The data used for this study were collected using the Michigan National Animal Health Monitoring System (NAHMS), a cooperative state, federal, and industry effort to provide statistically sound estimates of animal health events and associated costs in selected states. The design, herd characteristics, and data collection procedures have been reported earlier.[13] Briefly, NAHMS conducted a longitudinal study in which individual farms were studied for a 12-month period. Michigan dairy producer data were collected in 2 rounds: from June 1986 to June 1987, and from January 1988 to January 1989. Data were collected at 3 phases of dairy producer involvement: an initial survey and management survey at the beginning of producer participation; monthly animal health events during the course of the round; and the same management survey at the end of producer participation. The initial survey was administered before monthly animal health event data collection began, and collected data on general herd management. The monthly data, collected by veterinary medical officers included the herd inventory, reproductive events, preventive measures administered, and disease on the farm for the previous calendar month. Preventive measure data consisted of the types of diseases being prevented, the preventive measures, the age group, and the number of animals receiving the measures. Disease data included the disease, who diagnosed the disease in animals, numbers of cases, outcomes, and treatments used. In addition, adult cow disease records for each cow were maintained on a separate worksheet.

Antibiotics and sulfonamides—The veterinary medical officers were asked to record either brand names or generic equivalents of products used for treatment or prophylaxis. Both types of information were stored on computer, and efforts were made to identify the contents of treatments identified by a product name. Statistical analyses were performed on the basis of the active ingredients of products. Whenever possible, antibiotic and sulfonamides were grouped as either aminoglycosides, bacitracin, cephalosporins, lincomycin, macrolides, nitrofurans, novobiocin, penicillins, polymyxins, spectinomycin, tetracyclines, and sulfonamides. In some circumstances, treatments were preparations made by the producer's veterinarian, who identified the treatment with their own name (ie, "Red Ram", "Blue"). When this occurred, the veterinary medical officer contacted the producer's veterinarian for a list of the active ingredients in the treatment.

Animal-months were computed from herd inventories as the sum of the number of live animals reported in the herd at the end of any given month. There were 13,610 calf-months, 90,243 young stock-months, and 99,863 cow-months covered in the 2 rounds.

Preventive drugs—Because the number of head receiving a preventive drug was recorded in all age groups each month, it was possible to compute the number of animal-months receiving preventive drugs. Counting each animal receiving preventive drugs was not possible, because each animal was not identified and it is possible for an animal to receive such a drug more than once during the month.

Treatment drugs—Because the worksheet monitored adult cows on an individual basis, it was possible to count animal-months actually receiving a treatment for disease. However, this was not possible for calves (animals from birth to weaning) and young stock (animals from weaning to first calving), because the only disease information collected for these age groups were monthly inventories, which captured the numbers of sick, recovered, dead, and culled animals. There was no provision for identifying which animals received what treatment, if any. In an effort to capture the number of uses of antimicrobial drugs for treatment in these 2 age groups, the number of head that might possibly have received treatment was used as an estimator for drug use.

Patterns of antibiotic and sulfonamide use were examined by using equation 1:

$$\text{Proportional drug use} = \frac{\text{NMonths}_{XY}}{\text{NMonths}_{X}} \times 100$$

where NMonths_{XY} = the number of months of using drug Y for treatment of disease X; and NMonths_{X} = the number of months of disease X.

This proportion does not describe the absolute numbers of treatments, but the patterns of preference for drug use. The proportions can show which drugs are more used for a specific disease, and how the use of a drug changes from disease to disease.

Herd size was also examined as a factor affecting drug use. The Michigan NAHMS herd size stratifications were used: stratum 1 = 10 to 49 adult cows, stratum 2 = 50 to 99 cows, stratum 3 = 100 to 199 cows, and stratum 4 = 200 cows or more. The number of herds selected from each size category were chosen to reflect 1% of all Michigan herds. Ninety-six herds were monitored over the 2 rounds: 32 from stratum 1, 40 from stratum 2, 18 from stratum 3, and 8 from stratum 4.

Because herd size strata were determined by the number of animals in a herd, absolute numbers are an inappropriate measure of antimicrobial use for comparison between strata. Strata with larger numbers of animals will have greater numbers of drug use simply because there are more animals in the population that can be treated. It was more informative to examine the proportions of drugs used within a stratum, using equation 2:

$$\begin{array}{c}\text{Stratum proportional}\\ \text{drug use}\end{array} = \frac{\text{NMonths}_{SXY}}{\text{NMonths}_{SX}} \times 100$$

*Table 1—Animal-months of preventive drug use for selected disease groups by age group**

	Antibiotics			Sulfonamides			Both drug groups		
Disease group	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Breeding	0	2	244	0	0	18	0	0	262
Calving	0	0	13	0	0	0	0	0	13
GastroIntest	309	0	1,266	24	0	0	333	0	1,266
Mastitis	0	0	3,226	0	0	4	0	0	3,230
Meta/nutrition +	0	0	0	0	0	3	0	0	3
Multiple system	0	0	10	0	0	0	0	0	10
Respiratory	423	40	14	0	0	0	423	40	14

*Age groups: A = calves (birth to weaning), B = young stock (weaning to first calving); C = cows; †Meta/nutrition = metabolic and nutritional problems (eg nutritional myopathy [white muscle disease], parturient paresis [milk fever]).

where NMonths_{SXY} = the number of months of using drug Y for treatment of disease X in stratum S; and NMonths_{SX} = the number of months of disease X in stratum S.

This proportion does not describe the absolute number of treatments, but the patterns of preference for drug use. The proportions can show which drugs are more used within a stratum, and how the use of a drug changes from stratum to stratum.

Veterinary presence was examined to see whether or not the presence of a veterinarian during diagnosis of disease affected drug use. Proportions were calculated as in equation 3:

$$\begin{array}{c}\text{Veterinary presence}\\ \text{proportional drug use}\end{array} = \frac{\text{NMonths}_{VXY}}{\text{NMonths}_{VX}} \times 100$$

where NMonths_{VXY} = the number of months of using drug Y for the treatment of disease X with veterinarian present at the time of diagnosis; and NMonths_{VX} = the number of months of disease X with veterinarian presence at the time of diagnosis.

To further examine the effect of veterinary presence on the use of specific groups of drugs by disease groups, odds ratios of using a given drug for a specific disease with veterinary presence at diagnosis were computed by the use of equation 4:

$$\begin{array}{c}\text{Odds of drug Y use}\\ \text{for disease X}\\ \text{with veterinary}\\ \text{presence}\end{array} = \frac{\left(\dfrac{\text{NMonths}_{VXY}}{\text{NMonths}_{VY}}\right)}{\left(\dfrac{\text{NMonths}_{VX}}{\text{NMonths}_{V}}\right)} \times 100$$

where

NMonths_{VXY} = the number of months using drug Y for the treatment of disease X with veterinarian present at diagnosis; NMonths_{VY} = the number of months using drug Y for the treatment of all diseases except X, with veterinarian present at diagnosis; NMonths_{VX} = the number of months using all drugs except Y for disease X, with veterinarian present at diagnosis; and NMonths_{V} = the number of months using all drugs except Y for the treatment of all diseases except X, with veterinarian present at diagnosis. This does not compute actual rates of drug use on disease, but allows an evaluation of how the drugs used were distributed by disease and veterinary presence at diagnosis.

Statistical analysis—To examine the effects of herd size on drug use, stratified analysis and χ^2 tests were computed by the use of the statistical program DEPID.[14] Similarly, stratified analysis was used to investigate whether the presence of veterinarians on the farm affected drug use. Odds ratios from stratified analysis were checked for significance at 95% confidence intervals, and χ^2 were tested for significance, using probabilities of 0.05 ($P \leq 0.05$).

Results

Preventive drugs—The largest numbers of preventive drugs for calves were used for respiratory tract and gastrointestinal tract conditions; respiratory tract conditions in young stock; and mastitis, gastrointestinal tract, and breeding problems (including metritis) in cows (Table 1). Most preventive drugs for mastitis were dry treatments. Sulfonamide use was not as widespread as antibiotic use. Sulfonamides were used for preventive use only for gastrointestinal tract problems in calves and breeding problems in cows, and in each case, sulfonamide use made up only a small percentage (7.2% and 6.9%, respectively) of drugs used.

In calves (Table 2) and cows (Table 3), penicillin, tetracyclines, aminoglycosides, and cephalosporins made up 86.6% of all antimicrobial preventives administered. Calves were receiving preventive drugs only for 2 disease groups, whereas cows were receiving drugs for many more disease groups. In the case of cows, only the top 5 diseases being prevented were listed. The other disease groups for which adult cows received preventive drugs were multiple system problems and metabolic/nutrition diseases (10 and 3 head treated over 2 rounds, respectively), which were not included. In young stock, the only disease group receiving drugs were respiratory tract problems, with chlortetracycline being the drug most used.

Table 2—Animal-months of antibiotics and sulfonamides used for disease prevention in calves

Drug Type	Gastrointestinal tract disease	Respiratory tract disease	All diseases
Aminoglycosides	151	201	352
Tetracyclines	126	222	348
Macrolides	31	0	31
Sulfonamides	24	0	24
Penicillins	1	0	1

Table 3—Animal-months of antibiotics and sulfonamides used for disease prevention for top five diseases in cows

Drug type	Mastitis	Gastrointestinal tract disease	Breeding	Respiratory tract disease	Calving	All diseases
Penicillins	1424	0	26	0	0	1450
Tetracyclines	0	1266	51	0	0	1317
Cephalosporin	859	0	0	0	0	859
Aminoglycosides	582	0	60	0	0	642
Novobiocin	474	0	0	0	0	474
Erythromycin	165	0	0	0	0	165
Sulfonamides	4	0	25	0	0	29
Spectinomycin	0	0	30	0	0	30
Polymyxin	0	0	18	0	0	18

Disease treatment—Aminoglycoside and sulfonamide use decreased with age, whereas tetracycline and (to a lesser extent) penicillin use increased (Fig 1). Penicillin, tetracyclines, aminoglycosides, and sulfonamides made up 81.2% of all antimicrobial drugs used for disease treatment.

Herd size—Penicillin use remained fairly steady between herd size strata (Fig 2). Through stratified analysis, only aminoglycoside use showed any pattern in relation to herd size, with use decreasing as herd size increased ($P \leq 0.05$).

For calves, tetracycline use decreased and sulfonamide use increased in the larger herd size categories, and aminoglycoside use decreased substantially in the largest herd group (Fig 3). In young stock, each stratum had different patterns of drug use, and there were no trends noticed (Fig 4). Because this age category had few uses of drugs recorded, it is possible that there were not enough data collected to distinguish any trends.

Because cows received more antibiotics and sulfonamides than any other age group, they make up the basis for overall drug use patterns (Fig 5).

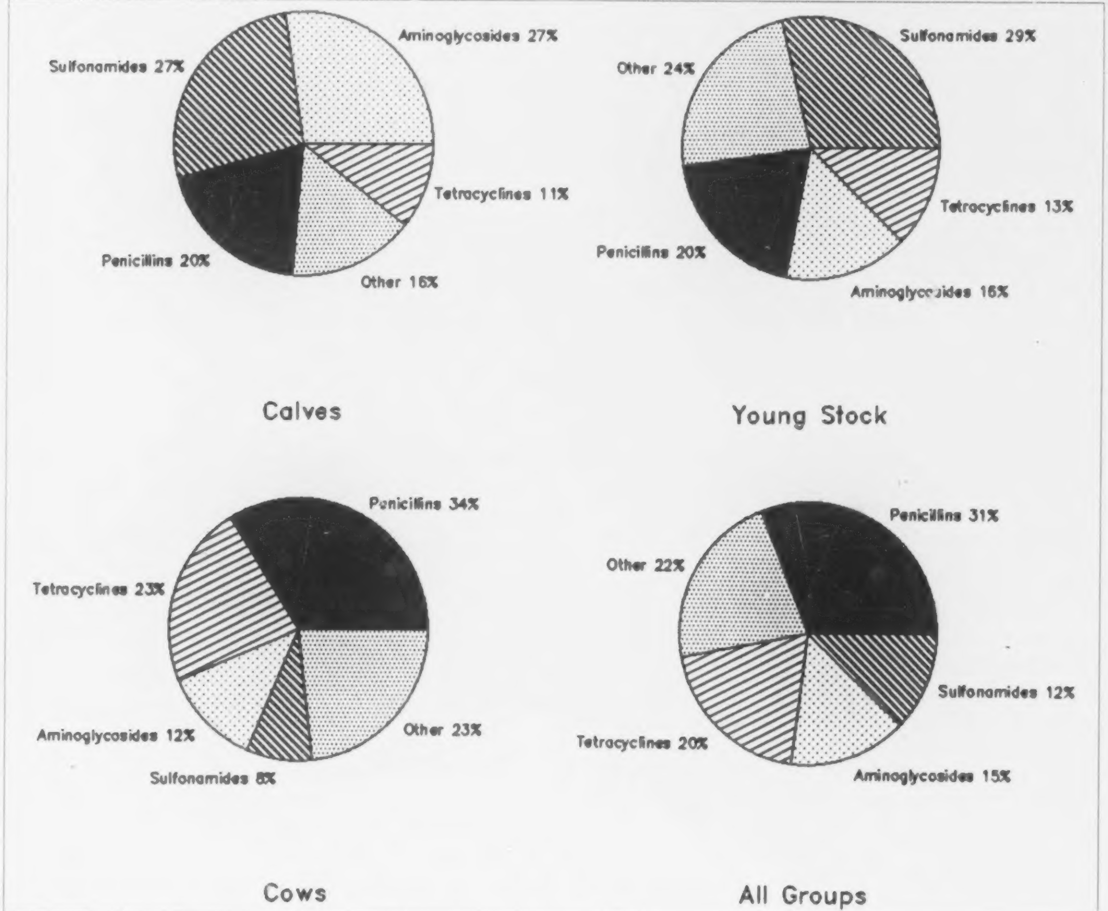


Figure 1—Proportional drug use by age group

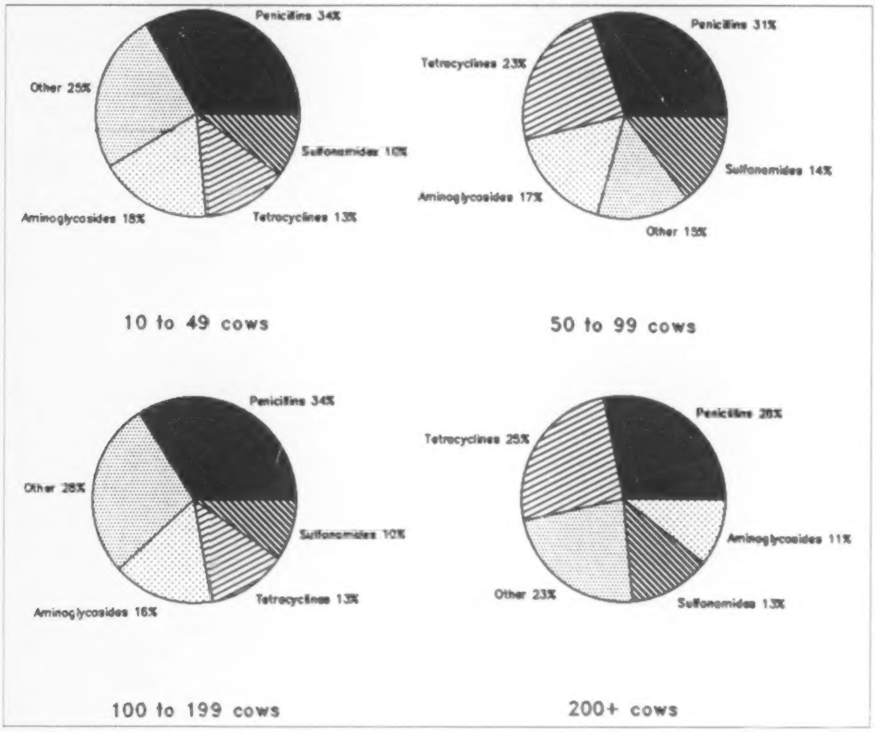


Figure 2—Proportional drug use by herd size stratum

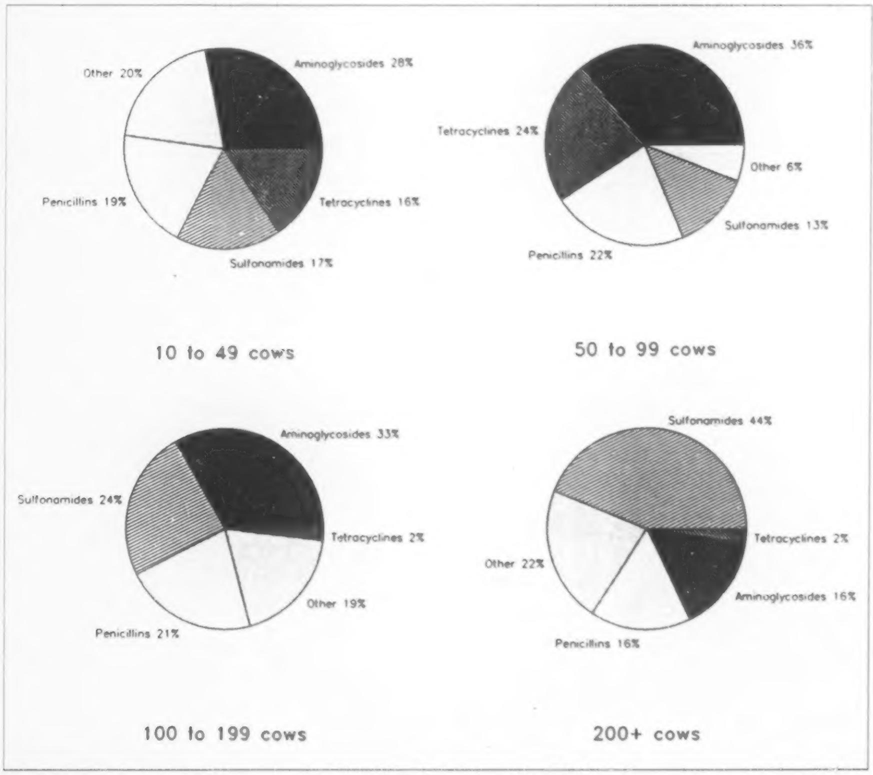


Figure 3—Proportional drug use for calves by herd size stratum

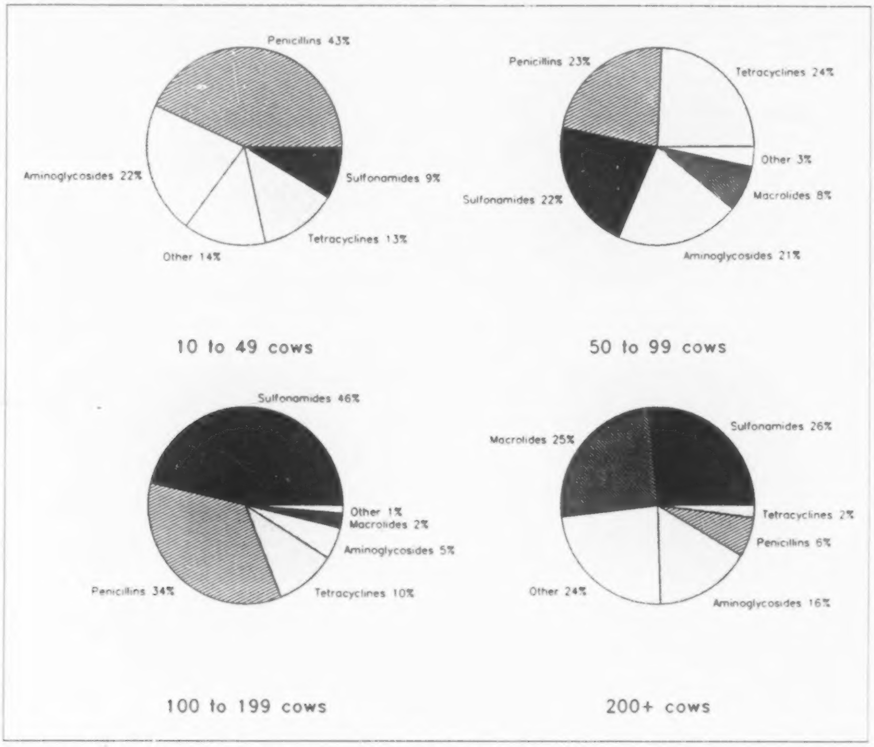


Figure 4—Proportional drug use for young stock by herd size stratum

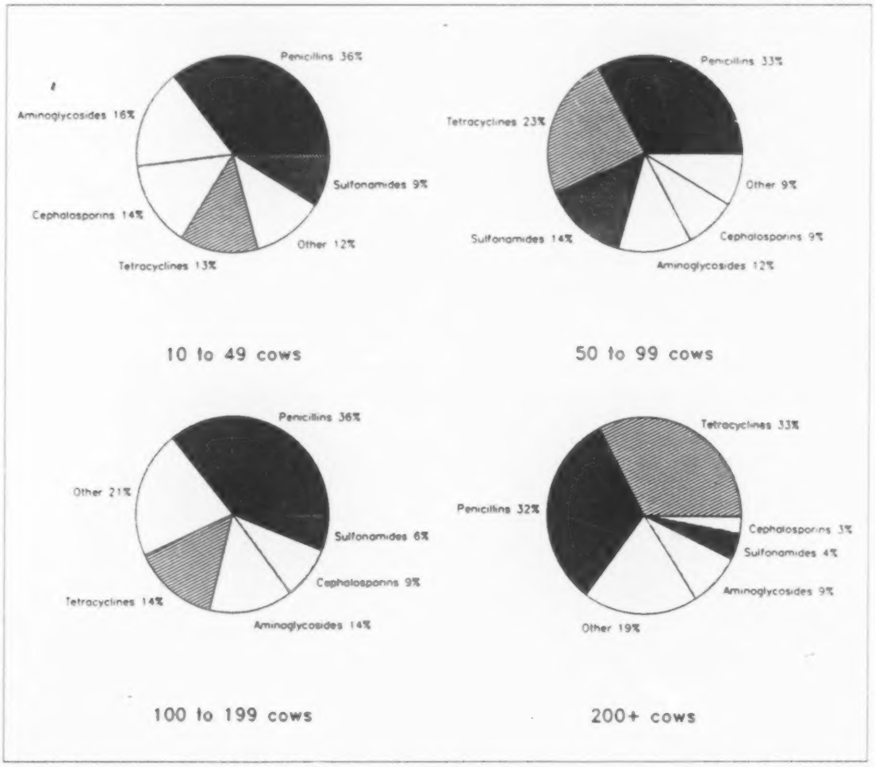


Figure 5—Proportional drug use for cows by herd size stratum

Table 4—Odds ratios for using drugs for all diseases in all age groups with the presence of a veterinarian at diagnosis

Drug type	Calves	Young stock	Cows	All age groups
Penicillins	0.952	0.268*	0.491*	0.558*
Tetracyclines	0.625*	1.164	3.243*	2.749*
Aminoglycosides	0.839	0.513*	0.744*	0.633*
Sulfonamides	1.805*	32.059*	1.371*	1.315*
Cephalosporins	3.359	†	0.418*	0.475*
Nitrofurans	NA	†	2.404*	2.677*
Novobiocin	†	NA	0.207*	0.228*
Spectinomycin	0.059*	1.362	1.777*	1.216*
Macrolides	0.398*	1.092	0.899	0.937
Polymyxins	3.216*	NA	1.210	1.303*
Lincomycin	†	†	0.145*	0.099*
Chloramphenicol	†	NA	NA	†

*Odds ratio is significant (at 95% confidence interval); †Unable to compute odds ratio, one of two counts was 0.
NA = Not available; no use recorded.

Penicillin, aminoglycoside, and sulfonamide use remained fairly constant between strata. Cephalosporins decreased in use with increase in herd size. Tetracyclines were reasonably consistent between strata 1 and 3 (10 to 49 and 100 to 199 cows, respectively). Tetracycline use increased about 10% in stratum 2 (50 to 99 cows), and experienced a large increase in stratum 4 (200 or more cows), with the proportion of use more than double that in stratum 1 or 3.

Table 5—Odds ratios for using specific drugs for diseases in calves with the presence of a veterinarian at diagnosis

Drug type	Gastrointestinal tract disease	Respiratory tract disease	All diseases
Sulfonamides	2.637*	0.907	1.805*
Aminoglycosides	0.570*	1.405	0.839
Penicillins	2.171*	−0.999	0.952
Tetracyclines	0.178*	2.093*	0.625*
Macrolides	0.098*	0.774	0.398*
Spectinomycin	0.090*	0.074*	0.059*
Polymyxins	2.798*	†	3.216*
Lincomycin	NA	†	†
Chloramphenicol	†	NA	†
Cephalosporins	NA	†	3.359
Novobiocin	NA	†	†

See Table 4 for key.

Veterinary presence—The drug groups were examined by using equation 3 to identify what part of the total use of the drug occurred with and without the presence of a veterinarian at the time of diagnosis for all diseases (Table 4). Because most treatments administered were in cows (n = 14,119; vs 2,703 for calves and 748 for young stock), overall trends closely reflect those trends seen in cows. Tetracycline, sulfonamide, nitrofuran, spectinomycin, and polymyxin use were positively associated with veterinary presence, and penicillin, aminoglycoside, cephalosporin, novobiocin, and lincomycin use were negatively associated with veterinary presence (odds ratios significant at 95% confidence interval). In calves, producers used antibiotics on their own more than with a veterinarian present, with the exception of sulfonamides, polymyxin, and chloramphenicol. The reverse is true for young stock: producers used antibiotic and sulfonamides on their own less than they did with a veterinarian present, with the exceptions of penicillins and aminoglycosides. In cows, veterinary presence was variably associated with the use of drugs.

Veterinary presence increased the odds of sulfonamide, penicillin, and polymyxin use, and decreased odds of aminoglycoside, tetracycline, macrolide, and spectinomycin use for gastrointestinal tract problems (odds ratios significant at 95% confidence interval; Table 5). Veterinary presence increased tetracycline use and decreased spectinomycin use for respiratory tract problems in calves (odds ratios significant at 95% confidence interval). Overall, veterinary presence increased odds for sulfonamides and polymyxins, and decreased odds of tetracycline, macrolides, and spectinomycin use for all diseases in calves (odds ratios significant at 95% confidence interval). All lincomycin

Table 6—Odds ratios for using specific drugs for diseases in young stock with the presence of a veterinarian at diagnosis

Drug type	Respiratory tract disease	MultiSystem disease	Gastrointestinal tract disease	Lameness	All disease
Sulfonamides	†	†	NA	NA	32.059*
Penicillins	0.224*	2.963	3.000	0.500	0.268*
Macrolides	1.184	0.178	NA	NA	1.092
Tetracyclines	1.220	0.178	†	†	1.164
Aminoglycosides	0.251*	†	3.000	0.750	0.513*
Spectinomycin	1.857	0.067*	3.000	NA	1.362
Nitrofurans	NA	†	NA	NA	†
Cephalosporins	†	NA	NA	NA	†
Lincomycin	NA	NA	NA	†	†

See Table 4 for key.

Table 7—Odds ratios for using specific drugs for diseases in cows with the presence of a veterinarian at diagnosis

Drug type	Mastitis	Breeding	Calving	Lameness	Gastrointestinal tract disease	All Disease
Penicillin	0.636*	1.457*	1.201	1.398	2.682*	0.491*
Tetracycline	3.075*	1.093	1.110	0.637	0.863	3.243*
Aminoglycosides	1.486*	0.832	0.914	0.164	0.376*	0.744*
Sulfonamides	2.485*	0.447*	0.721*	9.137*	0.430*	1.371*
Nitrofurans	†	0.679*	0.094*	2.815*	2.894	2.404*
Novobiocin	0.398*	†	0.348	†	NA	0.207*
Spectinomycin	1.837*	3.668*	†	NA	†	1.777*
Polymyxins	0.989	2.129*	†	NA	†	1.210
Cephalosporins	0.913	NA	†	NA	†	0.418*
Macrolides	1.320	0.458	†	0.884	0.531	0.899
Lincomycin	0.115*	0.542	†	NA	†	0.145*

See Table 4 for key.

and novobiocin use was without a veterinarian present, and all chloramphenicol use was with a veterinarian present.

Sulfonamides were used in young stock only with a veterinarian present (Table 6). Penicillin and aminoglycoside use were significantly reduced for respiratory tract problems when a veterinarian was present (odds ratios significant at 95% confidence interval), and spectinomycin use was reduced for multiple system health problems when veterinarians were present (odds ratios significant at 95% confidence interval). Low numbers of disease treatments for this age group make conclusions about less frequently used drugs impossible.

On the basis of veterinary presence (using equation 4), odds ratios for drugs used for different diseases in cows varied greatly (Table 7). Overall, veterinary presence was associated with increased use of tetracyclines, sulfonamides, and nitrofurans, and decreased use of penicillins and aminoglycosides.

Discussion

We found that antimicrobial drug use in Michigan dairy farms is widespread, and that several different types of antibiotics and sulfonamides are commonly used. Four important points warrant special attention: patterns of drug use were similar in all herd size categories, drug use varied between the 3 age categories, veterinary presence at the time of diagnosis had effects on the patterns of use of antibiotics and sulfonamides, and producers use antibiotics and sulfonamides more on their own than when a veterinarian is present at the time of diagnosis. Specifically, veterinary presence at diagnosis was associated with increased use of tetracyclines, sulfonamides, and nitrofurans, and decreased use of penicillins and aminoglycosides.

These findings indicate that the presence of a veterinarian on the farm does affect how producers select and use antimicrobial drugs. Three factors should be taken into consideration before producers use drugs on food animals: proper medical indications for use of the specific drug, public health implications of any potential drug residues, and the implications of having drug residues in milk for dairy product processing. Efforts should be made to make producers interact more effectively with practitioners before the use of antibiotics and sulfonamides. Veterinarians can make producers more aware of residue avoidance strategies, and provide them with the information necessary to use these drugs properly.

One unexpected finding was chloramphenicol use in calves when a veterinarian was present. This type of use was found in 1 large herd for 2 months. This herd suffered heavy losses from winter dysentery in their calf crop. Of 29 calves on the farm, all contracted diarrhea and 22 died. In addition to chloramphenicol,[a] the calves received *Escherichia coli* monoclonal antibodies, bovine rota-coronavirus vaccine, trimethoprim and sulfadiazine,[b] and penicillin/streptomycin and methylprednisone.[c] It is possible that everything available was tried, including chloramphenicol.

Recently, sulfonamide boluses for intrauterine use have been taken off the market. This may have a noticeable impact on sulfonamide use for the prevention of breeding problems and treatment of metritis and retained placenta. Removal of these boluses will appear to immediately decrease sulfonamide use, but it is highly probable that other antibiotic preparations will be used in their place, as was the case in the removal of chloramphenicol from food animal use.

Unexpectedly, we found that the most common antimicrobials found in milk, sulfonamides and tetracyclines, were used more with veterinarians present. This finding may be coincidental, or may happen under several scenarios: veterinarians properly provide the drugs in question to the producers, who then do not use the drugs as recommended, extra-label use makes the withdrawal times provided with the drugs irrelevant, or the information on withholding times that are currently available may not be usable. In the first situation, information may be provided, but the need to adhere to withdrawal times may not be reinforced in the farmers' minds. The farmers may not understand the potential problems of ignoring withdrawal times, they may not understand that drugs provided for 1 specific purpose should not be used in other circumstances without veterinary consultation, or they may decide that the potential drawbacks of improper drug use may be outweighed by perceived immediate benefits. In the second scenario, veterinarians themselves use drugs in extralabel circumstances. For example, lincomycin HCl[d] was found to be used in this study, and it is only recommended for use in dogs, poultry, and swine. Withdrawal times may vary between species, and simple adherence to recommended withdrawal times for those species may not be adequate. In the third scenario, information on withholding times provided to the veterinarian may not be adequate. To treat early postpartum uterine infections, oxytetracycline concentrations in uterine tissues must be at least 15 $\mu g/g$. However, recommended doses of oxytetracycline are 10 mg/kg of body weight, which result in tissue concentrations $< 5\ \mu g/g$.[15] Therefore, doses must be increased to meet therapeutic needs, and recommended withholding/withdrawal times will not be adequate considering the increased doses.[16]

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[a] Chloromycetin, Parke-Davis Division of Warner-Lambert Co, Morris Plains, NJ.

[b] Tribrissen, Coopers Animal Health Inc, Kansas City, Mo.

[c] Bio-delta, The Upjohn Company, Kalamazoo, Mich.

With so many different products on the market, it is important to encourage producers to involve their practitioners in the decision to use new drugs in their herds. Different methods should be used to pass this information to producers. Extension programs (particularly at the local level), presentations at producer group meetings, articles in farming magazines, and information via major milk processing groups can be used as pathways to get this information to the producers. The veterinary profession needs to develop specific mechanisms to communicate this information to producers as altruistically as possible. These methods should go beyond the routine veterinarian-client relationship, even though this will always be the primary form of communication. More active interaction between veterinarians and farmers will improve the quality of health care their herds receive, and will ultimately improve producer profits by reducing the risk of antibiotic residues and their attendant costs.

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[d] Lincocin, The Upjohn Company, Kalamazoo, Mich.

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Cystine-containing urinary calculi in dogs: 102 cases (1981-1989)

Lisa C. Case, DVM; Gerald V. Ling, DVM; Charles E. Franti, PhD; Annette L. Ruby, BA;
Fredric Stevens, DVM; Deedra L. Johnson, BA

Summary: *One hundred and seven cystine-containing urinary calculi from 1 female and 101 male dogs were analyzed. Cystine-containing calculi accounted for 2% (107 of 5,375) of all canine urinary calculi submitted to the urinary stone analysis laboratory from July 1981 through December 1989. Male dogs that formed cystine calculi were compared with 3 other canine populations to determine whether certain breeds were apparently at increased or decreased risk for cystine calculus formation. In one or more of 3 population comparisons, significantly increased risk of cystine calculus formation was found in Mastiffs, Australian Cattle Dogs, English Bulldogs, Chihuahuas, Bullmastiffs, Newfoundlands, Dachshunds, Basenjis, Australian Shepherd Dogs, Scottish Deerhounds, Staffordshire Terriers, Miniature Pinschers, pitbull terriers, Welsh Corgis, Silky Terriers, and Bichon Frises. Significantly low risk of cystine calculus formation was found in German Shepherd Dogs, Poodles, Schnauzers, and mixed-breed dogs.*

Cystinuria in dogs results from an inherited defect in the renal proximal tubular transport system that allows excessive urinary excretion of cystine, and variably other amino acids.[1-4] Because it is insoluble in urine, precipitation of cystine and the formation of cystine calculi is a potential problem; otherwise, loss of the amino acid(s) in the urine has no clinical significance.[1] Although cystinuria may occur in male and female dogs,[1,5] cystine calculi have been reported only in males, with 2 exceptions.[6,7]

The prevalence of cystine calculi reported in the literature varies greatly. In Europe, cystine calculi account for 15 to 40% of all calculi from dogs.[3,8-10] In the United States, the prevalence of cystine calculi is much lower. Most studies cite a prevalence of 2.4 to 3.8%,[11-13] but reported prevalence has been as high as 22%.[6] The mean age at the first episode of cystine urolithiasis is approximately 4.8 years,[1,6,9] which is younger than for other types of calculi.[6]

The exact pattern of genetic transmission of canine cystinuria is obscure because it does not follow a simple Mendelian pattern.[1] Inheritance probably is sex-linked; however, an incomplete autosomal recessive mode of inheritance cannot be conclusively ruled out.[1,14-16] If canine cystinuria is genetically transmitted, the genes must be widespread in the dog population because cystinuria has been found in a large number of diverse breeds as well as in mixed breeds.[6-8,11]

Cystine calculi have been reported most frequently in Dachshunds.[1,5,6,8,10,11] Other breeds with frequently reported occurrences of cystine calculi include Basset Hounds,[6,11,17,18] Beagles,[6] Bulldogs,[6-8,17] Chihuahuas,[6,7,17,18] Welsh Corgis,[8,18] Miniature Schnauzers,[6] Poodles,[6] and mixed-breed dogs.[6-8,18] However, in most studies, an attempt was not made to determine the relative risk of these breeds for the formation of cystine calculi. The primary reason cited was lack of information about the breed distributions in the populations from which the dogs came.[8,11]

The purpose of the study reported here was to review a large number of cases of cystine urolithiasis and determine whether certain breeds of dogs are apparently at increased or decreased risk for cystine calculus formation.

Criteria for Selection of Cases

A computer-assisted search of records of the urinary stone analysis laboratory, University of California disclosed 107 specimens of cystine-containing urinary calculi from 102 dogs. Records surveyed were of 5,375 calculi that were submitted for analysis between July 1981 and December 1989.

Materials and Methods

Calculus specimens—Specimens had been surgically removed and mailed to the laboratory for determination of their mineral composition. The size, weight, and physical appearance of each

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From the Urinary Stone Analysis Laboratory, Department of Medicine (Case, Ling, Ruby, Johnson), and Department of Epidemiology and Preventive Medicine (Franti, Stevens), School of Veterinary Medicine, University of California, Davis, CA 95616.

Address requests for reprints to Dr. Ling.

Table 1—Risk (odds ratio) of cystine calculus formation in male dogs, by breed, compared with other canine populations*

Breed	Cystine calculi population (n = 106)		Stonelab population† (n = 2,530)		VMTH population‡ (n = 46,305)		
	Dogs	Dogs	Odds ratio	(*P*)	Dogs	Odds ratio	(*P*)
Mastiff	9	9	26.0	(0.0)	103	41.6	(0.0)
Australian Cattle Dog	8	9	22.9	(0.0)	34	111.1	(0.0)
English Bulldog	12	38	8.4	(0.0)	277	21.2	(0.0)
Chihuahua	9	33	7.0	(0.0001)	422	10.1	(0.0)
Bullmastiff	5	6	20.8	(0.0001)	47	48.7	(0.0)
Newfoundland	4	6	16.5	(0.0001)	117	15.5	(0.0)
Pitbull terrier	2	13	3.7	(0.09)	27	33.0	(0.0)
Dachshund	9	52	4.4	(0.0002)	1,363	3.1	(0.0015)
Basenji	3	6	12.2	(0.0004)	110	12.2	(0.0002)
Miniature Pinscher	1	3	8.0	(0.07)	24	18.4	(0.005)
Bichon Frise	1	40	0.59	NS	25	17.6	(0.0057)
Welsh Corgi	2	24	2.0	NS	129	1.9	(0.007)
Australian Shepherd Dog	3	14	5.2	(0.01)	536	2.5	NS
Scottish Deerhound	1	1	24.1	(0.025)	36	12.2	(0.013)
Staffordshire Terrier	1	1	24.1	(0.025)	224	2.0	NS
Silky Terrier	1	14	1.7	NS	59	7.5	(0.05)
Alaskan Malamute	1	4	6.0	NS	203	2.2	NS
Samoyed	2	16	3.0	NS	433	2.0	NS
Scottish Terrier	1	9	2.7	NS	182	2.4	NS
West Highland White Terrier	1	10	2.4	NS	118	3.7	NS
Cairn Terrier	1	12	2.0	NS	100	4.4	NS
Basset Hound	1	20	1.2	NS	336	1.3	NS
Great Dane	1	16	1.5	NS	827	0.52	NS
Poodle	3	135	0.52	NS	2,820	0.45	NS
Yorkshire Terrier	1	140	0.16	NS	328	1.33	NS
Dalmatian	1	230	0.10	NS	363	1.21	NS
Schnauzer	2	275	0.16	(0.01)	527	1.67	NS
German Shepherd Dog	1	81	0.29	NS	4,491	0.09	(0.016)
Mixed breed	19	418	1.1	NS	11,494	0.66	(0.10)
Labrador Retriever	0	68	0.16	NS	2,619	0.08	(0.073)
Golden Retriever	0	57	0.21	NS	1,384	0.15	NS
Doberman Pinscher	0	82	0.14	NS	1,602	0.13	NS

*Breeds are listed in approximate decreasing order of statistical significance (*P* value; 2-tailed), compared with at risk (OR > 1) breeds at the top, and protected (OR < 1) breeds at the bottom. Three common breeds with no cystine stones are included for comparison (zeros were replaced by 0.5 for odds ratio calculations). †Male dogs forming calculi of any mineral type, for which the calculi were submitted to the urinary stone analysis laboratory (Stonelab) from July 1981 through December 1989 (n = 2,530). ‡Male dogs admitted to the Veterinary Medical Teaching Hospital (VMTH), University of California, from January 1969 through December 1988 (n = 46,305).

NS = not significant ($P > 0.10$).

specimen were recorded, and a determination of the mineral composition was made by crystallographic analysis, using polarized light microscopy.[19] A qualitative chemical spot test[a] also was used as an aid in the analysis of some specimens.

Dogs—The age, breed, and gender of the affected dogs were recorded as were location of the calculi within the urinary tract and the state in which each dog resided. An attempt was made to determine the number of episodes of calculi preceding the episode from which the specimen was submitted.

Statistical methods—To determine whether certain breeds of dogs were apparently at increased or decreased risk for cystine calculus formation, the male dogs in this study (cystine calculi population) were compared with 3 other canine populations: (1) male dogs that formed calculi of any mineral type that were analyzed by the urinary stone analysis laboratory between July 1981 and December 1989 (Stonelab population); (2) male dogs admitted to the Veterinary Medical Teaching Hospital (VMTH) from January 1969 through December 1988 (VMTH population); and (3) dogs seen in 2 community surveys of pet owners in northern California (general population).[20,21] For each comparison, odds ratios were calculated and tested for significance with a *z*-test.[22]

Results

Of 5,375 canine urinary calculi submitted to the laboratory, 107 (2%) contained cystine. The cystine calculi were submitted from veterinary practices in 21 states. The state of residence of dogs with cystine calculi was similar to that of dogs with urinary calculi of all other mineral types that were analyzed by the laboratory. In particular, more than half of the specimens of each type of calculus (58 of 107 cystine; 3,024 of 5,268 other) came from dogs from California. Of the remaining specimens, most came from dogs in states in which schools of veterinary medicine are located.

The cystine calculi came from 101 male dogs and 1 female English Bulldog (specimens were analyzed from 2 episodes of calculus formation from each of 5 dogs). Twenty-seven breeds and a mixed-breed group were represented. Mixed breeds were most often represented (19 specimens from 17 dogs), followed by English Bulldogs (13 specimens from 12 dogs), Chihuahuas and Dachs-

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[a] Oxford stone analysis set, Lancer Div, Sherwood Medical Industries Inc, St Louis, Mo.

Table 2—Risk (odds ratio) of cystine calculus formation in selected breeds of male dogs, compared with dogs of either gender† in 2 community surveys in California*

Breed	Cystine calculi population (n = 108)	Yolo County population[20]			Alameda/Contra Costa Counties population[21]		
	Dogs	Dogs	Odds ratio	(P)	Dogs	Odds ratio	(P)
Chihuahua	9	23	3.13	(0.005)	10,773	1.83	(0.08)
Dachshund	9	27	2.66	(0.014)	12,319	1.59	NS
Basset Hound	1	8	0.94	NS	1,548	1.37	NS
Mixed breed	19	293	0.38	(0.0002)	118,745	0.19	(0.0)
Poodle	3	111	0.18	(0.004)	41,616	0.13	(0.0004)
German Shepherd Dog	1	42	0.17	(0.083)	27,224	0.07	(0.008)

*Other breeds experiencing cystine calculi were sufficiently rare that those breeds did not appear in the breed distribution for either the Yolo County survey of 1,091 households or the Alameda/Contra Costa survey. †Breed by gender distribution was not published in either survey. NS = not significant ($P > 0.10$).

hunds (9 specimens each), Mastiffs (9 specimens from 8 dogs), and Australian Cattle Dogs (8 specimens from 7 dogs; Table 1).

When the population of male dogs with cystine calculi was compared with the Stonelab population, significantly ($P < 0.05$) high risk of cystine stone formation, relative to the formation of stones of any type, was found in 11 breeds (Table 1). These same breeds, with the exception of the Australian Shepherd and the Staffordshire Terrier, also were found to have significantly increased risk of cystine stone development when compared with the VMTH population. In addition, 5 other breeds had significantly ($P < 0.05$) increased risk of cystine stone formation when compared with the VMTH population (Table 1). A "protective" value of breed was found for German Shepherd Dogs, Labrador Retrievers, and mixed-breed dogs when the VMTH population was used as the comparison group, and for Schnauzers when the Stonelab population was used as the comparison group.

In comparison to the general canine population studied in 2 northern California community surveys (Table 2), significantly ($P < 0.05$) increased risk of cystine calculus formation was found for Chihuahuas and Dachshunds, confirming the high risk seen in these breeds in the 2 clinical comparison groups. In this community-based comparison, Poodles, German Shepherd Dogs, and mixed-breed dogs had significantly ($P < 0.05$) low risk of forming cystine calculi.

Fifty-one (48%) of the specimens were from the first episode of calculus formation. The ages of these dogs ranged from 10 months to 11 years (mean, 4.5 years). Thirty-six (34%) specimens were from the second episode of calculus formation. The ages of the dogs in this group ranged from 1 to 14 years (mean, 5.4 years). Two specimens were from the third episode of calculus formation and 1 specimen was from the sixth episode of calculus formation in an 8-year old West Highland White Terrier. Information regarding number of episodes was not available for 17 (16%) specimens. All but 1 of the specimens were removed from the urinary bladder or the urethra. The only exception was a renal calculus specimen that was removed from a Bullmastiff.

Ninety-two (86%) of the specimens were composed only of cystine. Fifteen (14%) specimens were composed of mixtures of mineral substances. Fourteen of these contained cystine plus 1 additional mineral substance, which was either struvite (5 instances), urate, silicate, or oxalate (2 instances each), or calcium apatite (1 instance). The noncystine mineral substance could not be identified in 2 specimens. A single specimen contained 3 minerals: cystine, brushite, and urate. Thirteen of the 15 mixed specimens contained 2 distinct layers; 2 were composed of a single layer.

Discussion

The cystine calculus found in the female English Bulldog was previously reported.[7] This dog was not included in the population comparisons.

The mean age of the dogs at the first episode of cystine calculus formation (4.5 years) is similar to that reported by others.[1,6,9] The mean age of dogs at their second episode was approximately 1 year older (5.4 years). It has been stated that, in the absence of treatment, cystine stones commonly recur within 6 to 12 months.[1] Recurrence rates for cystine calculi of 47 to 75% have been reported.[9,23]

Cystine calculi accounted for 2% of all urinary calculi in dogs in this study, a value slightly less than in studies previously reported in the United States.[11-13] The prevalence of cystine calculi reported in the literature varies greatly.[3,6,8-13] These differences probably reflect a number of factors. As found in our study, breed predispositions apparently exist for cystine calculus formation, thus the prevalence of cystine calculi may vary with the breeds of dogs encountered in each survey. Prevalence as high as 60% has been reported for cystine calculi when only selected breeds are included.[17] Even among breeds predisposed to cystine calculi, the prevalence may vary depending on the genetic strain, the geographic location (eg, Europe vs United States), and the time of collection.[24] The method used to analyze the calculi also is a crucial factor. Quantitative analysis is far superior to qualitative analysis, with < 50% agreement between the 2 methods in the case of cystine calculi.[12,25] Because the recurrence rate of cystine calculi is higher than for most other types of calculi,[9,23] prevalence will vary depending on whether single or multiple episodes are included in the statistical data analyzed.[6]

Selection of suitable populations for study and comparison is a formidable task. No single comparison group is perfect; each has its inherent bias. For this reason, 3 population comparisons by breed were made in this study. Although there was some variation in breeds considered at risk of forming cystine calculi, depending on which population was used for comparison, results from all 3 populations were in general agreement.

It has been stated in a similar study of calculi from widespread sources, that lack of knowledge about the popularity of the various breeds within their respective populations of origin precludes formulation of the relative risk of each breed for urolith formation.[11] We faced a similar dilemma in this study, because calculi were submitted from 21 states. However, as a subset, the geographic distribution of the cystine calculi population was generally similar to the geographic distribution of the larger Stonelab population to which it was compared. The purpose of this first comparison (cystine calculi population vs Stonelab population) was to determine cystine-specific risks in dogs forming calculi.

The second comparison, that of cystine calculus-formers with dogs receiving veterinary care (VMTH population), is of particular clinical interest to veterinarians. This comparison is the type most often used in epidemiologic surveys. Hospital populations are biased in that they represent the distribution of dogs with conditions requiring veterinary attention, and may not be representative of the total canine population. Unfortunately, workable alternatives are limited. For example, American Kennel Club figures include only a small proportion of all dogs and do not include the most popular category, mixed breeds. Because more than half of the calculi in this study were submitted from California, comparison with hospital admissions primarily from California was deemed appropriate.

The third and most general comparison made was of male dogs having cystine calculi with the distribution of dogs in 2 northern California communities. This type of comparison is useful in assessing the risks of urolith formation in the various breeds of dogs in the community, irrespective of whether they are receiving veterinary care. Although the county surveys included dogs of both genders, the published reports indicated approximately equal gender ratios (eg, 1.04 in Alameda County[21]). Although these surveys were conducted 20 years ago, the breeds that were popular then (mixed-breed dogs, Poodles, German Shepherd Dogs, Dachshunds) remain among the most popular now, as reflected by their high incidence in the VMTH population.

Although the odds ratios for individual terrier breeds were not often significant, as a group, they appeared to have a higher than expected risk of cystine calculus formation. This may be an illustration of a heritable defect that is more frequently manifested among breeds with a close genetic relationship. In spite of the fact that cystinuria has been identified in a large number of diverse breeds, published pedigrees of inheritance of cystinuria represent only terrier breeds.[14,16,26] Further investigation into the inheritance of cystinuria in nonterrier breeds with apparent high risk of cystine calculus formation (eg, Mastiffs, Bullmastiffs, Australian Cattle Dogs) might be warranted. In addition, other factors should be considered besides the inheritance of a renal transport defect, which might predispose certain breeds to the formation of cystine calculi.

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A3100-2

August 1, 1992, Volume 201, Number 3

JOURNAL
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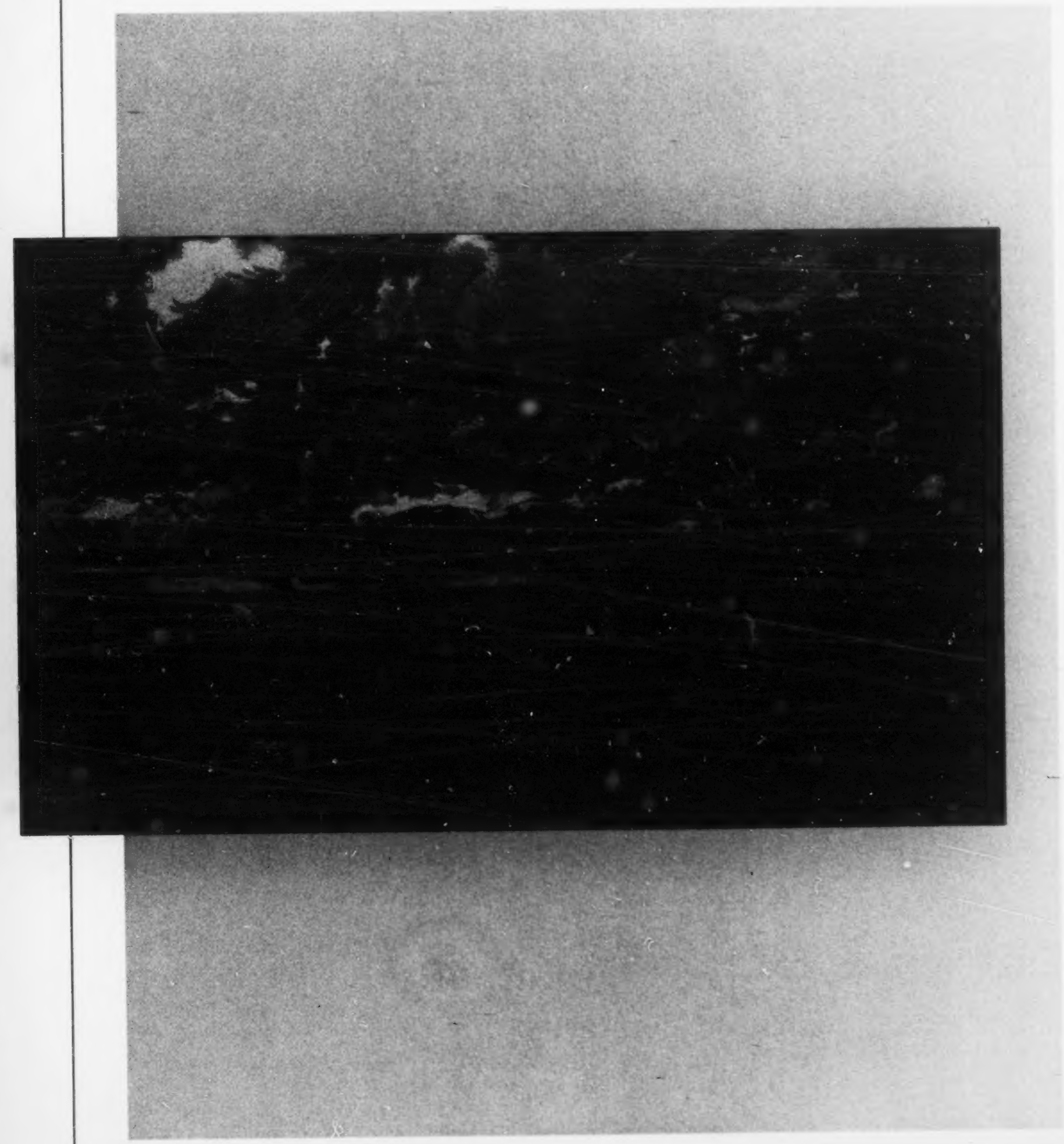

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 201 August 1, 1992 No. 3
JAVMA 201 (3) 369-520 (1992)
ISSN 0003-1488

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Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

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BPA

Survey: technicians underpaid

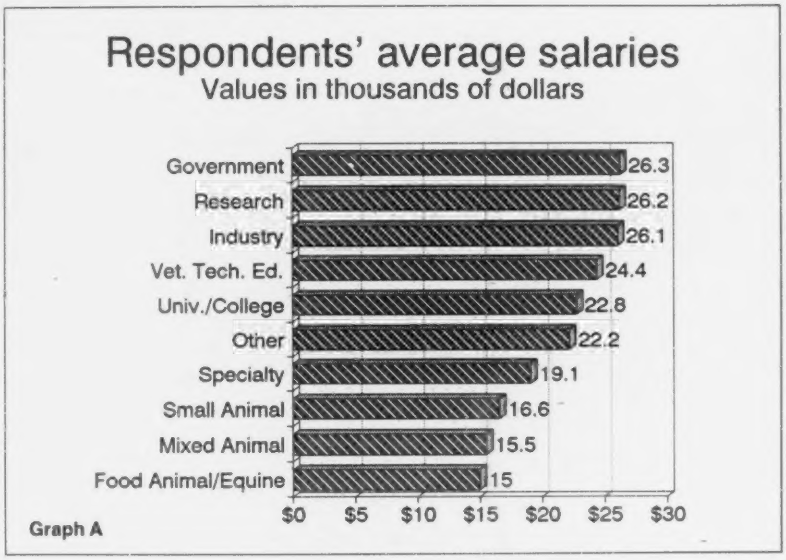
What is the number one issue facing veterinary technicians today? What will be the most important issue facing them five years from now? It is not surprising that 74% of respondents to a national survey of veterinary technicians conducted by the North American Veterinary Technician Association (NAVTA) in 1991 (*JAVMA*, July 1, 1992, p 33) indicated low pay as the answer to both questions.

The survey was distributed to three target groups: NAVTA members for 1991, members in 1990 who did not renew in 1991, and nonmember subscribers of *Veterinary Technician.*

Graph A, which illustrates the average salary of respondents by employment type, is based on an average of seven years' employment. Salaries range widely among employment types. The highest-paying jobs currently exist in veterinary technology education, government, research, and industry. Respondents working in small animal, mixed animal, and food animal/equine practices earned less than the overall average salary for respondents. The low pay in practice settings could be one of the reasons for the increasing shortage of veterinary technicians in these areas. It appears that technicians may be seeking employment in areas providing a higher income, better benefits, and opportunity for career advancement.

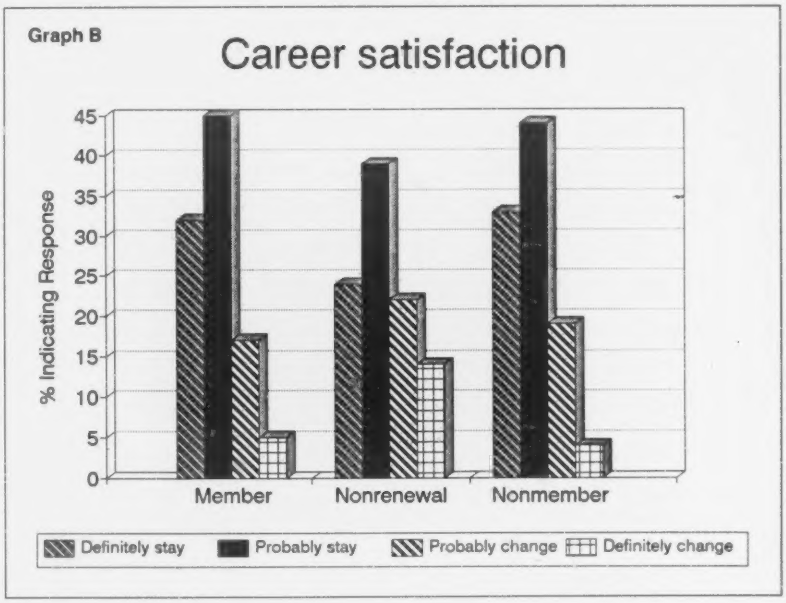
Benefits

The NAVTA also surveyed respondents about the types of benefits provided by their employers. The two benefits received by the highest percentage of respondents are paid vacation (84%) and free or discounted animal care (83%). Amazingly, only 63% of respondents receive health insurance from their employer and only 57% are compensated for hours worked over 40. On the average, a large percentage of respondents do not receive benefits that many employees take for granted.



Graph A

Graph B



Career satisfaction

The low salaries and lack of employment benefits contribute directly to the career dissatisfaction of many veterinary technicians. Respondents were asked to answer the following question: "How satisfied are you with your career in veterinary technology?" Respondents were given four choices:

- I'm satisfied and will definitely stay in veterinary technology.
- I will probably stay in veterinary technology in the future.
- I will probably change to another field in the future.
- I'm dissatisfied and will definitely change to another field.

Of the 1,616 respondents in the

Continued on 389

STUDENT AND SCHOOL SCENES

Refractory epilepsy study on dogs begins

The Morris Animal Foundation has funded a study titled "Comparison of Combination Anticonvulsant Therapies in the Treatment of Refractory Canine Epilepsy," in the amount of $51,600.

Directing the study at the Texas Veterinary Medical Center, Texas A&M University are Drs. Dawn Boothe and Charles Hall.

The three-year project, which began July 1, will study potassium bromide, clorazepate, and mephenytoin in combination with phenobarbital.

Case referrals will be accepted throughout the country, and a visit to Texas A&M is not necessary. Client benefits will include the cost of medication and reimbursement for up to 50% of diagnostic and monitoring costs.

"A refractory epileptic is defined in this study as a patient that is still experiencing seizures despite therapeutic serum phenobarbital concentrations, or a patient that is experiencing drug-induced hepatotoxicosis," Dr. Boothe said. "Success of the study will depend on our ability to acquire an adequate number of refractory epileptic patients."

Anesthesia papers invited

The American College of Veterinary Anesthesiologists has issued an invitation for abstracts for its annual scientific meeting, Oct 16, 1992 in New Orleans.

Frank Murphy, Jr, MD, diplomate of the American Board of Anesthesiology, will speak on anesthesia residency training.

All abstracts relating to anesthesia will be considered. The deadline for abstract submission will be September 1. Contact Dr. David Hodgson, Department of Clinical Sciences, College of Veterinary Medicine, Kansas State University, Manhattan, KS 66506; phone (913) 532-4258.

UNDER THE UMBRELLA

Correction

One of the diplomates newly certified by the American College of Veterinary Surgeons, Dr. David E. Holt, was identified incorrectly in the June 1 issue. Dr. Holt is on faculty in the Department of Clinical Studies, University of Pennsylvania School of Veterinary Medicine, Philadelphia.

Ophthalmology Society elects officers

The American Society of Veterinary Ophthalmology held its 35th annual meeting in late April during the AAHA's annual meeting in New Orleans.

One of the Society's founders and first president, Dr. William Magrane, Osceola, Ind, was recognized by outgoing president, Dr. Harry Schadler, Columbus, Ohio.

Officers elected for 1992-1993 are Drs. Thomas Cusick, Watertown, Mass, *president;* Mary Belle Glaze, Baton Rouge, La, *president-elect;* William Ebinger, Rochester, Mich, *Board member;* and A. J. Quinn, Stillwater, Okla, *secretary/treasurer.*

TECHNICIANS TODAY

Survey . . . from 388

three target groups, 27% indicated they may leave the field, compared with even more—36%—in the nonrenewal category.

Graph B indicates the responses given by each target group.

Of members, nonrenewals, and nonmembers, 22%, 36%, and 23%, respectively, are probably or definitely going to change to another field. Continued attrition from the working veterinary technician pool will make the technician shortage even more serious.

Summary

Respondents were asked to rate the following statement: "Veterinary technicians are so underpaid that the feasibility of staying in the profession is declining." Using graduated responses from "strongly agree" to "no opinion," more than 89% of respondents either strongly agree or agree with this statement.

The message is clear. Respondents feel that they are underpaid and that important benefits are lacking. One quarter are considering leaving the field. Meeting the challenge of solving this problem and ensuring the continued survival and development of the veterinary health-care team will require a collective effort from veterinary and veterinary technician groups.

Written by A. Patrick Navarre, RVT, a veterinary technology instructor and operating room supervisor in the Large Animal Clinic at Purdue University in West Lafayette, Ind, and Carlene Decker, CVT, a veterinary technology instructor at Parkland College in Champaign, Ill. They are the NAVTA Task Force members responsible for implementing the grant from Hill's Pet Products to conduct this survey.

Morbidity and mortality in pups from pet stores and private sources: 968 cases (1987-1988)

David W. Hird, DVM, PhD; Randall P. Ruble, DVM; Stephen G. Reagor, DVM;
Pamila K. Cronkhite; Michael W. Johnson

Summary: *Morbidity ($\geq$ 1 disease condition) for pups sold from 3 pet stores from January 1987 through December 1988 ranged from 54 to 68%. In 1 store, morbidity was higher for store pups, compared with pups originating from private parties, for such disease conditions as "kennel cough," diarrhea, and several species of gastrointestinal parasites. In-store mortality ranged from 5 to 9.5% of pups arriving for sale.*

Clients frequently ask veterinarians to recommend sources of pups. In addition, health examination of recently purchased pups is necessary, not only for welfare of the animal in terms of disease detection, treatment, and prevention, but also as a legal mechanism to protect the client's investment. It is therefore important for veterinarians to have quantitative information regarding the rates of disease conditions in pups, and to know how these rates may differ among pups purchased from various sources. There is little population-based information available.[1]

The objective of the study reported here was to determine rates of disease conditions in pups from 3 franchised pet stores. We hoped that these baseline data would be useful for veterinarians, not only to monitor health of populations of pups in pet stores, but also as an aid to health evaluation of pups in clinical veterinary practices.

Materials and Methods

Health-related data were collected for pups sold from January 1987 through December 1988 from 3 northern California franchise pet stores of the same chain (stores A, B, and C), using standard definitions for disease conditions. Disease rates in pups sold at 2 stores were determined from records of postpurchase veterinary examination, and in the third store by a mailed survey to purchasers. In 1 store, rates of disease conditions were compared between pups purchased from the pet store and pups obtained from private sources. In-store morbidity was determined for pups in 1 store, and mortality was obtained for pups from 2 stores. Stores B and C were studied because of reported health problems in pups. Because of this selection method, we do not know whether rates of illness or death in pups from the stores we studied were representative of those in all northern California pet stores.

Definitions of disease conditions—The following definitions were used to collect data from records. Definitions were based on clinical signs and/or laboratory test results. Treatment regimen also was recorded. Canine infectious tracheobronchitis (kennel cough) was defined as a clinical syndrome with such characteristic signs as cough in the absence of fever, and usually was treated with chloramphenicol or trimethoprim.[2] Diarrhea and/or vomiting were recorded if listed in the record as client history or observed by the veterinarian or animal care personnel. The term severe gastroenteritis was applied to conditions of pups with characteristic clinical signs compatible with intestinal viral infection (eg, parvovirus) including hemorrhagic gastroenteritis, fever, leukopenia ($\leq$ 6,000 WBC), and usually was treated with antibiotics, antispasmodics, and fluids. All dogs in this category had hemorrhagic gastroenteritis and fever; most also had leukopenia. Tapeworm was defined as observation of proglottids by client or veterinarian. The determination of other intestinal parasites (*Giardia* spp, coccidia, *Toxocara* spp, *Ancylostoma caninum, Trichuris vulpis*) was based on examination of feces by flotation technique. Dermatitis was defined as characteristic clinical signs of bacterial infection, and/or typical signs of dermatomycosis accompanied by fluorescence under Wood's lamp and treatment with griseofulvin or other antifungal drug. Otitis externa was consid-

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From the Department of Epidemiology and Preventive Medicine, School of Veterinary Medicine, University of California, Davis, CA, 95616 (Hird, Ruble); the Sun Valley Animal Hospital, 1130 Contra Costa Blvd, Concord, CA 94523 (Ruble); the Reagor Pet Hospital, 2513 Walnut Ave, Carmichael, CA 95608 (Reagor, Johnson); and The Sonoma Humane Society, 5465 Highway 12, Santa Rosa, CA 95401 (Cronkhite). Ms. Cronkhite's present address is Marin Humane Society, 171 Bel Marin Keys, Novato, CA 94949.

The authors thank Susan Hatch and Jan Brewer for data collation.

ered to be a clinical condition characterized by inflammation of the ear and presence of exudate, which was often a dark brown waxy material. Mites may or may not have been detected by microscopic examination of smear or scraping. Distemper was defined by clinical signs of fever, mucopurulent nasal and ocular discharge, anorexia, and diarrhea.

Store A—All pups arriving at store A were examined for physical defects by the contract veterinarian. Pups that subsequently died in the store before sale were taken to the contract veterinarian's clinic for disposal. Annual in-store pup mortality was defined as number of dead pups taken for disposal (numerator) divided by number of pups examined for physical defects (denominator) each year. Purchasers of pups from store A were given a certificate for a free health examination of the pup from the contract veterinarian. The certificate was valid for 14 days after purchase. Each pup examined received a complete physical examination. Fecal examination for parasites was performed only for those pups with diarrhea. Complete records were kept for each pup examined. Records of initial postpurchase health examinations (within 14 days of sale) from this contract veterinary clinic were reviewed for the contract period Jan 1, 1987 through Dec 31, 1988. Data were available only for those pups that did not subsequently become regular patients of the clinic.

Store B—Data on post purchase health examination of 6- to 20-week-old pups, purchased from pet store B, were abstracted from the records of a private multiperson veterinary clinic for the 9-month period October 1987 to June 1988. During this period, the clinic was under contract to store B to provide veterinary services. Pups purchased from this store were entitled to a free health examination at the contract veterinary clinic if brought in within 72 hours of purchase. During this same 9-month period, many newly acquired pups from sources other than store B were also examined, as part of routine (noncontract) clinic activities. All pups, regardless of source (eg, pet store, private party) were given the same thorough physical examination, including fecal examination. Complete clinical records were kept for each visit.

Data abstracted from each record included age at first examination at the clinic, source, and presence of health-related conditions. Clients were later contacted by telephone to obtain information on source of the pup if it was not listed in the clinical record. Conditions were recorded with respect to time of diagnosis after sale. For example, for pups purchased from store B, a condition first diagnosed at initial examination or within 6 days after initial examination was recorded as having developed ≤ 9 days of sale. Conditions for pups from other sources were recorded in a similar fashion.

Store C—These data pertained to pups from a third northern California pet store, store C, and had 2 main sources: pet store records and a mailed survey to purchasers of pups.

Pet store records were obtained for the period Jan 1, 1988 through Dec 31, 1988. For each pup, information on breed, origin (breeder), date of birth, date of arrival at store, and date of sale were abstracted from store records. Reports of in-store illness and death were obtained from standardized medical history forms in each pup's file, from notes kept in daily store logs by employees, and from written communications from contract veterinarians who had examined ill pups at the store.

Post-sale health information was obtained by means of a mail survey during late December 1988 and January 1989. A standardized questionnaire (copy available from authors on request) was mailed to every person listed in the pet store files as having purchased a pup during 1988, and for whom an address was available. Data obtained included postsale health history; and date and results of postsale health examination and name of attending veterinarian. For 19 dogs, additional information (especially date of initial postpurchase examination) was obtained by subsequently contacting the veterinarians who initially examined and treated these pups. Data were reported only for conditions that developed ≤ 1 week after purchase.

Statistical analysis—The χ^2 test for independence was used to assess statistical significance.

Results

Store A—In-store mortality for pups in store A was 50/944 (5.3%) in 1987 and 52/735 (7.1%) in 1988. Postpurchase health examination data were available for 19% and 16% of pups sold from store A for 1987 and 1988, respectively. Sixty percent of 170 pups examined in 1987 and 68% of 110 pups examined in 1988 were found to have 1 or more disease condition (Table 1). Kennel cough, diarrhea, and *Giardia* spp infection were the most common conditions reported.

Store B—Records of 399 6- to 20-week-old pups were examined. Of these, 135 had been purchased from pet store B, and the remainder were obtained from other sources: private party, 207; humane society shelter, 17; other pet stores, 9; stray, 7; county animal shelter, 5; other, 1; and unknown, 18.

Rates of health-related conditions were compared between pups purchased from store B and private party-source pups (Table 2). Conditions in store-B pups were diagnosed within 9 days of sale. Over half of store-B pups had 1 or more health-related conditions, nearly twice the rate of pups obtained from private sources. Rates of kennel cough, diarrhea, and *Giardia* spp infection were higher in store-B pups, compared with pups obtained from private sources. The rate of severe gastroenteritis

Table 1—Disease conditions diagnosed during initial postpurchase examination of pups purchased at pet store A during 1987 and 1988

Condition‡	**1987* No. (%)§**	**1988† No. (%)§**
Kennel cough	60(35.3)	46(41.8)
Dermatitis	8 (4.7)	4 (3.6)
Otitis externa	17(10.0)	18(16.4)
Diarrhea	53(31.2)	26(23.6)
Giardia infection	13(24.5)	12(46.2)
Coccidia infection	10(18.9)	3(11.5)
Toxocara infection	2 (3.8)	3(11.5)
Vomiting	16 (9.4)	5 (4.5)
One or more of above conditions	102(60.0)	75(68.2)

*170 pups examined; †110 pups examined; ‡Definitions of conditions: kennel cough, a clinical syndrome with cough in the absence of fever, usually treated with chloramphenicol or trimethoprim sulfa[2]; dermatitis, clinical signs of bacterial infection, and/or typical signs of dermatomycosis accompanied by fluorescence under Wood's lamp and treatment with griseofulvin or other antifungal drug; otitis externa, a clinical condition characterized by inflammation of the ear and presence of exudate, with or without presence of mites; diarrhea and/or vomiting, signs observed by client or veterinarian; Intestinal parasites (*Giardia* spp, coccidia, *Toxocara* spp, *Ancylostoma caninum, Trichuris vulpis*), examination of feces by flotation technique; severe gastroenteritis, characteristic clinical signs compatible with intestinal viral infection (eg, parvovirus) including hemorrhagic gastroenteritis, fever, leukopenia (WBC $\leq$ 6,000), usually treated with antibiotics, antispasmodics, and fluids; tapeworm, observation of proglottids by client or veterinarian; distemper, clinical signs of fever, mucopurulent nasal and ocular discharge, anorexia, and diarrhea; §Denominators for fecal parasite rates were number of pups with diarrhea because laboratory examinations for fecal parasites were only performed for pups with diarrhea.

was higher for private-source pups, although not significantly so (0.7% vs 2.9%). Trends for conditions found within 16 days of sale were similar to those observed within 9 days of sale (data not shown).

Store C—Store-C records indicated that 346 pups were received from suppliers during 1988. Of these, 328 (94.8%) were from 3 large out-of-state suppliers, 2 (0.6%) from a California breeder, and 16 (4.6%) from unknown sources. Sixty-three (18.2%) were < 8 weeks old at arrival. Of those 63, 59 (93.6%) originated from breeders outside of California. Of the remaining 4 pups $\leq$ 8 weeks old at arrival, 2 originated in California, and the origin for 2 was undetermined.

Proportions of the 346 pups that were recorded as having been ill during their stay in the store or that died before sale were determined (Table 3). Vomiting and/or diarrhea, severe gastroenteritis, and kennel cough were the most frequently recorded conditions. Thirty-three pups (9.5%) died before sale. Of the 63 pups that arrived at the store when they were < 8 weeks old, 35-(55.6%) were reported as subsequently becoming ill, compared with 137 of 283 (48.4%) pups arriving at store when they were $\geq$ 8 weeks old ($P > 0.2$).

Of the approximately 200 questionnaires mailed, 115 (approx 58%) were returned (Table 4). Kennel cough and vomiting and/or diarrhea were the conditions that were reported most frequently. Nearly half (47.8%) of these pups had had 1 or more disease conditions within 7 days after purchase, and 7 (6.1%) had died because of illness first diagnosed $\leq$ 1 week after sale.

Table 2—Disease conditions in 6- to 20-week-old pups purchased at pet store B, compared with rates in pups obtained from private sources for conditions diagnosed within 9 days of purchase

Condition	**Pet store B* No. (%)**	**Private source† No. (%)**
Kennel cough‡	33(24.4)	4 (1.9)
Severe gastroenteritis	1 (0.7)	6 (2.9)
Diarrhea	17(12.6)	14 (6.7)
Giardia infection‡	28(20.7)	15 (7.2)
Coccidia infection‡	12 (8.9)	2 (1.0)
Toxocara infection‡	7 (5.2)	23(11.1)
Ancylostoma caninum infection	1 (0.7)	0 —
Trichuris vulpis infection	1 (0.7)	0 —
Tapeworm infection	5 (3.7)	7 (3.4)
Dermatitis	2 (1.5)	0 —
Otitis externa	1 (0.7)	3 (1.4)
Distemper	1 (0.7)	1 (0.5)
Vomiting	8 (5.9)	18 (8.7)
Died§	2 (1.5)	4 (1.9)
One or more of above conditions‡	73(54.1)	57(27.5)

*135 pups examined; †207 pups examined; ‡Difference between rates significantly different ($P \leq 0.05$); §Died of illness first observed $\leq$ 9 days after acquisition.

See Table 1 for definitions of conditions.

Table 3—Disease conditions observed before sale in pups received at pet store C between December 1987 and November 1988

Condition	**No. (%)***
Kennel cough	15(4.3)
Severe gastroenteritis	17(4.9)
Vomiting and/or diarrhea	23(6.6)
Coccidia infection	4(1.2)
Intestinal parasites (not coccidia)	1(0.3)
Dermatitis	7(2.0)
Died in store	33(9.5)

*346 pups were examined, an individual pup may have had more than one disease condition.

See Table 1 for definitions of conditions.

Table 4—Disease conditions observed within 1 week after purchase for pups sold at pet store C between Jan 1, 1988 and Dec 31, 1988

Condition	**No. (%)***
Kennel cough	21(18.3)
Severe gastroenteritis	7 (6.1)
Dermatitis	6 (5.2)
Coccidia infection	5 (4.3)
Intestinal parasites (not coccidia)	6 (5.2)
Vomiting and/or diarrhea	17(14.8)
Other condition	8 (7.0)
One or more of above conditions	55(47.8)
Died as a result of illness†	7 (6.1)

*115 pups were examined; †Illness first observed 7 days or less after sale. Primarily severe gastroenteritis.

See Table 1 for definitions of conditions.

Discussion

Previous reports of diagnoses in populations of dogs have relied on data from veterinary school hospitals, where a proportion of the patient caseload often was referral patients from private veterinary clinics.[1] In our study, morbidity and mortality were determined for pups in pet stores and for those brought in for routine physical examinations at nonreferral veterinary clinics. We speculate that the population of pups examined in our study may have been more representative of the pet store pup population than that in other studies. However, 2 of the pet stores (B and C) were studied because of reported health problems in pups and, therefore, were not necessarily representative of stores as a whole, or even stores of the same chain. Extrapolation of our results to the population of pet store pups as a whole may not be justified. This issue could be addressed by randomly sampling pet stores, regardless of perceived health problems in pups.

In store A, health examination data were available for only a small proportion of the pups sold, and it is possible that the animals examined were not representative of all pups sold. Perhaps purchasers of ill pups were more likely to avail themselves of the free postpurchase examination, and/or were less likely to become regular clients, resulting in falsely high disease rates in our sample. Certainly not all purchasers of pups from store B brought them in for examination at the contract veterinary hospital. The proportion brought in was unknown, because the number of pups sold at store B during the study period was unavailable. It is possible that ill pups were more likely to have been brought in for examination at the contract hospital, resulting in falsely high disease rates. We also could speculate, in the store-C mailed survey, that owners of ill dogs were more likely to return the mailed questionnaire than owners of well dogs, yielding falsely high rates of disease. Recall may also have been a problem, because customers who purchased pups early in 1988 received the mailed questionnaire as long as a year after the purchase. All these factors may have adversely affected data validity.

Many outcomes in this study were clinical diagnoses (eg, diarrhea, vomiting, and death), and laboratory confirmation was not required. For other disease condition categories, laboratory diagnosis would have provided additional information, but was not possible because of the retrospective nature of the study.

In store B, the only category in which private-source pups had a significantly higher health condition rate was for *Toxocara* parasites. Most pups are infected with this parasite at birth, and the difference between the 2 groups might possibly be related to a higher treatment rate of store-B pups, compared with private-source pups. We believe that it was store policy to treat all pups for this parasite. The same may be true for the low rates of *Toxocara* spp found in pups from store A. The prevalence of *Toxocara* parasites in this study was much lower than that in the British report of 33% and 67% prevalence in treated and untreated pups, respectively.[3] Prevalence of *Giardia* spp in this study approximated the 35.9% in California pups reported previously.[4] For both parasites, methods of laboratory diagnosis differed among studies, making comparison of results difficult.

In store C, it is not known how complete and comprehensive in-store disease reporting was. However, it may be speculated that employees were not as highly trained or motivated with respect to disease recording as were employees of veterinary clinics. We believe it likely, therefore, that in-store disease conditions were underreported, and that the rates listed in Table 3 underestimated the true rates.

Rates of many disease conditions varied among pups from the 3 stores. In one instance, there was a reported outbreak of severe gastroenteritis among pups from store C, which accounted for higher rates of that condition in store-C pups. However, for other conditions, our preliminary data did not reveal whether these differences were real or were attributable to biases in the data, as previously discussed.

We recorded disease conditions as either present or absent, with no indication of severity. In future studies, it may be informative to also measure the duration and severity of such conditions as diarrhea and kennel cough as indicators of pup health.

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Nonsteroidal anti-inflammatory drug toxicosis in dogs and cats: 240 cases (1989-1990)

R. D. Jones, DVM; R. E. Baynes, DVM; C. T. Nimitz, BS

Summary: *A search of medical records at the Georgia Animal Poison Information Center over a 19-month period revealed 240 cases of dog and cat exposure to nonsteroidal anti-inflammatory drugs (NSAID). The most common NSAID consumed were ibuprofen, acetaminophen, aspirin, and indomethacin. The most common clinical signs of toxicosis were vomiting and diarrhea, CNS depression, and circulatory manifestations. Pets are at risk from NSAID toxicosis through administration by the owners or accidental consumption of improperly stored drugs.*

Pets are at risk for developing toxicosis to pharmaceuticals through administration of the medication by owners or accidental consumption of improperly stored drugs. During a 19-month period, 98% of the calls to the Georgia Animal Poison Information Center (GAPIC) requesting information regarding nonsteroidal anti-inflammatory drug (NSAID) toxicosis in pets were associated with 4 over-the-counter medications: ibuprofen, acetaminophen, aspirin, and indomethacin. The purpose of the study reported here was to evaluate records pertaining to the consumption of NSAID by pets to determine the type and degree of exposure, and to correlate the clinical signs of intoxication with the dose and type of drug.

Criteria for Selection of Cases

Using keyword and classification query language,[a] a retrospective search and analysis of written and computerized medical records of the GAPIC was conducted from Jan 1, 1989 to Aug 1, 1990. Data entry forms used by veterinary toxicologists for recording information at the GAPIC were standard Vet Tox Case Record report forms used by animal poison control centers.[b] All reported cases involving the generic compounds of the NSAID were included in this study.

The following data were compiled for each case: species, age, body weight, clinical signs, suspected NSAID, dose, time of exposure, duration of clinical signs, and source of the exposure. For purposes of analysis, pets were determined to have developed toxicosis if intake was observed of the drug and the subsequent clinical signs and time course for onset of signs were consistent with toxicosis of that drug. A case was considered "suspect" when the pet's clinical signs were consistent with toxicosis for a particular drug, but actual drug intake was not observed. A classification of "doubtful" toxicosis was made if drug intake was only suspected, and the clinical signs were inconsistent for toxicosis induced by that drug. If intake of the drug was observed, but there were no subsequent clinical signs attributable to toxicosis, the case was classified as only "exposure."

In addition, case records were evaluated as to the source or circumstances by which the pet consumed the NSAID. These were classified as "accidental" or "inappropriate" when the owner treated the animal with an incorrect dose or NSAID, or "appropriate" when the NSAID was given correctly.

Results

There were 4,588 inquiries to GAPIC for information about possible and toxicoses in dogs and cats during the 19 months. Of these, 3,545 (77.3%) were related to dogs and 1,043 (22.7%) were related to cats. The total number of calls concerning NSAID was 240 (5.2%), with 190 involving dogs (79.2%) and 50 involving cats (20.8%). The distribution of calls for the various NSAID were 120 for ibuprofen, 94 for acetaminophen, 18 for aspirin, and 8 for indomethacin.

Calls requesting assistance with suspected ibuprofen toxicosis in dogs involved 37 toxicoses, 29 suspects, 28 exposures, and 8 doubtful toxicoses according to the aforementioned classifications. Three of 240 calls were only requests for information about use of ibuprofen in dogs. Clinical signs were not observed at the time 42 of the calls were made, concerning the exposure of ibuprofen

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From the Georgia Animal Poison Information Center, Department of Physiology and Pharmacology, University of Georgia, Athens, GA, 30602.

[a] INFORMIX-4GL, Version 1.10, Informix Software, Inc, Menlo Park, Calif, 1987.

[b] GAPIC Vet Tox Case Record, The Board of Trustees, University of Illinois, 1990.

Table 1—Clinical signs reported in calls regarding nonsteroidal anti-inflammatory drug toxicosis in dogs and cats

	No signs		GI		Other		Urinary		CV/Resp		Total calls	
	Dog	Cat	Dog	Cat	Dog	Cat	Dog	Cat	Dog	Cat	Dog	Cat
Ibuprofen	35	7	25	7	12	11	5	...	4	...	81	25
Acetaminophen	38	5	5	...	34	26	2	...	...	...	79	31
Aspirin	7	5	3	...	...	4	...	...	...	...	10	9
Indomethacin	2	3	1	...	...	...	...	...	...	...	3	3

No signs = no clinical signs at the time of call; GI = vomiting, diarrhea, apparent abdominal pain, and regurgitation; Other = apparent depression, weakness, cyanosis, facial edema, methemoglobinemia, lethargy, and somnolence; Urinary = pollakiuria, polyuria; CV/Resp = tachypnea, dyspnea, tachycardia, and orthopnéa (. . .) = no clinical signs referable to this system.

in dogs and cats (Table 1). Clinical signs reported were more often related to the gastrointestinal tract (vomiting, diarrhea, hematochezia, regurgitation, and apparent abdominal pain). Clinical signs referable to the respiratory tract, urinary tract, and CNS were less common. Most of the ibuprofen exposures in dogs were accidental (86%) with inappropriate administration given as the source of exposure in only 6% of calls. Most of the cats were exposed accidently (75%), with inappropriate administration suggested in only 19% of the calls.

The number of calls regarding acetaminophen toxicosis was 69 for dogs and 26 for cats. Clinical signs were not reported in 38 of the dogs, or in 5 of the cats (Table 1). Clinical signs referable to the gastrointestinal tract were most often seen in dogs, but in cats circulatory manifestations (cyanosis, methemoglobinemia, extreme weakness, hypothermia) were most common. Accidental ingestion of acetaminophen accounted for most (75%) of the exposures in dogs, whereas the majority of exposures in cats (56%) were inappropriate administration of the drug.

There were 10 calls regarding possible aspirin toxicosis in dogs, and 4 in cats. The predominant clinical signs in dogs were vomiting, regurgitation, whereas in cats, CNS depression was most common (Table 1). All of the toxicosis in cats were the result of inappropriate administration by owners, whereas accidental ingestion resulted in 90% of the exposures in dogs. Of the 6 calls regarding possible indomethacin toxicosis, 3 were accidental ingestions by dogs with no clinical signs at the time of the call, and 3 were about cats that were inappropriately given the drug by owners.

All reports of ibuprofen and acetaminophen toxicoses were single oral intakes, with most doses at <100 mg/kg. One dog received a single dose of 1,600 mg/kg of body weight. Cats that ingested a single dose received <200 mg/kg.

A review of the data did not reveal any relationship between age, species, breed, or sex of the animal and reports of NSAID toxicosis.

Discussion

Ibuprofen is a propionic acid derivative known to induce gastrointestinal ulceration and renal dysfunctions (acute renal failure, acute interstitial nephritis, and hyperkalemia) in human beings.[1,2] Renal dysfunction results from the inhibition of cyclo-oxygenase prostaglandins (PGE2 and PGI2), which provide for vasodilatory compensation during inadequate renal blood flow.[3] Renal prostaglandins have little effect on basal renal blood flow or autoregulation, but play a major role in renal blood flow maintenance during systemic vasoconstrictor influences.[4-6] When effective circulating volume is inadequate, the adrenergic nervous system and the renin-angiotensin system are stimulated. Angiotensin II then stimulates the production of vasodilating prostaglandins, which act locally to offset vasoconstriction and maintain renal blood flow.[7] Although ibuprofen-associated nephropathies are often reversible after discontinuation of the drug, severe and prolonged renal hypoperfusion secondary to prostaglandin inhibition could lead to acute cortical necrosis and irreversible acute renal failure.[3,8,9]

The inhibition of prostaglandin synthesis by NSAID via the cyclo-oxygenase pathway interferes with the maintenance of gastric mucosal integrity.[1,10] Dogs are more predisposed than human beings to ibuprofen ulcerogenic effects because of higher gastrointestinal absorption rates and a longer drug half life, which leads to slower drug elimination and higher blood concentrations.[9,11] These pharmacokinetic factors narrow the margin of safety for using ibuprofen in dogs. Signs of pain and inflammation may be reduced by giving 5 mg/kg/d divided into 2 doses, whereas a dosage of 8 mg/kg/d is likely to induce gastrointestinal irritation and hemorrhage.[1]

Acetaminophen is a prostaglandin inhibitor known to cause Heinz body formation, methemoglobinemia, anemia, hemoglobinuria, and icterus.[12] Acetaminophen is rapidly absorbed from the gastrointestinal tract and is conjugated in most species by sulfation or glucuronidation. Because cats lack the specific glucuronyl transferase enzyme required to detoxify the reactive biotransformation metabolites of acetaminophen, these reactive metabolites bind to cellular macromolecules and can cause RBC lysis and hepatic necrosis. Cats should not be given acetaminophen at any dose, whereas clinical signs in dogs are not usually apparent until the dosage exceeds 100 mg/kg.

Aspirin, or acetylsalicylic acid, is a phenol derivative that inhibits prostaglandin synthesis by decreasing cyclo-oxygenase activity. The main route for aspirin elimination is conjugation with either glycine or glucuronic acid. Aspirin is toxic to cats because of the cat's limited glucuronyl transferase capacity. In cats, aspirin administration may cause anorexia, signs of depression, vomiting, convulsions, hyperthermia, and death.[13] Aspirin can be given to cats only at low doses, under certain medical conditions.[14,15]

Indomethacin inhibits gastric mucous secretion and is strongly ulcerogenic in dogs, causing hematemesis and melena.[10,16] Severe gastritis and duodenitis with multiple punctate erosions were found during exploratory celiotomy in a dog that was given indomethacin. Indomethacin decreases the rate of secretion of gastric mucus and the amount of carbohydrate in the mucosubstance,[17] but causes no noticable change in parietal cell population or gastric mucosal wall thickness.[18] Indomethacin should not be used in dogs.[15]

In this study, there may have been some bias in the information collected because our samples were obtained from calls made by veterinarians and owners that were unfamiliar with specific NSAID toxicoses and treatment protocols. In some communities and veterinary clinics, there may be a greater prevalence of toxic ingestion of these over-the-counter drugs, consequently, veterinarians and pet owners may be more experienced at managing such cases and less likely to call the GAPIC. For these reasons, the data presented here may not be a true reflection of the prevalence of NSAID toxicoses in the practice environment.

Our data suggest a higher prevalence of toxicoses attributable to accidental ingestion than from therapeutic use, and that toxicoses and potential toxicoses are frequent, and pet owners should be cautioned. Indiscriminate feeding habits of dogs may have led to the large numbers of accidental ingestions and large dose exposures. The lower dose exposures in cats suggests either that cat owners are exercising more caution or that cats are more selective in feeding habits. A more accurate picture of the prevalence of toxicoses involving this class of drugs might be obtained from a random survey of veterinary clinics.

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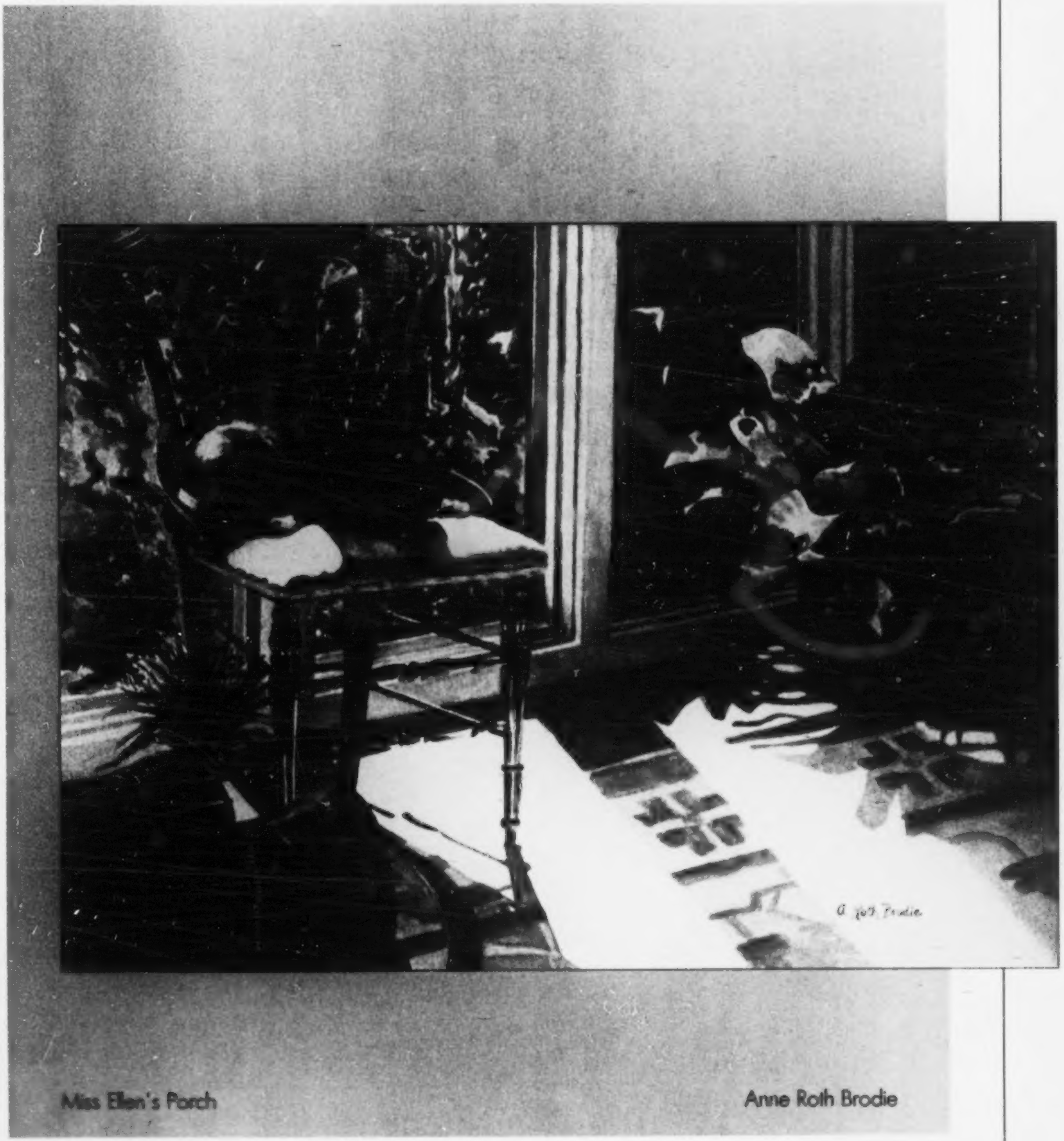
A3100-2

August 15, 1992, Volume 201, Number 4

JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION



Miss Ellen's Porch

Anne Roth Brodie

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 201 August 15, 1992 No. 4
JAVMA 201 (4) 521-656
ISSN 0003-1488

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Anne Roth Brodie is a pathology laboratory supervisor at the Yerkes Primate Research Center, Atlanta, where she conducts various clinical and research procedures for six veterinarians. Ms. Brodie, who is a self-taught artist, is a member of the American Society of Marine Artists and the Coast Guard Artist Program as well as an associate member of the Knickerbocker Artists of New York.

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SUBSCRIPTIONS: For one year: members $50; others $100 in the United States and possessions; $120 in foreign countries. Single copies: $6 in the United States and possessions; $8 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

ADDRESS CHANGE: Send new address (and moving date) 45 days ahead. Include old address as it appeared on previous issues (if possible send label).

POSTMASTER: Send address changes to JAVMA, 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360.

Comparative study of the knowledge, attitudes, and behaviors of large animal veterinarians, dairy farmers, and dairy processors in Michigan on bovine somatotropin

Jane R. Shaw, BS; Edward C. Mather, DVM, PhD; Mary Margaret Noel, PhD

Summary: *A cross-sectional epidemiologic study was conducted to evaluate two objectives. The first was to determine the knowledge, attitudes, and behaviors of large animal (dairy) veterinarians, dairy farmers, and dairy processors in Michigan toward the use of bovine somatotropin (BST). The second was to compare and contrast the data from the large animal veterinarians, dairy farmers, and dairy processors according to the knowledge, attitude, and behavior variables.*

A written questionnaire was used as an instrument to collect data relating to the objectives. Three basic types of questions were asked of each group: (1) how much do you know about BST? (knowledge-based question), (2) how do you feel about BST? (attitude-based question), and (3) how would you use BST or use dairy products produced through BST biotechnology (behavior-based question)?

Over the past decade, there have been numerous studies of scientific merit on bovine somatotropin (BST). Some information is known about the dairy industry's reaction toward the use of BST, and several studies have been performed to assess the reaction of consumers to the use of BST.[1,2] Few of these studies aid the development of a comprehensive and organized information system. There are many questions that are still unanswered. It is not known what kind of impact BST will have on society, how the dairy industry will respond to BST, or how consumers will respond to BST.

The objectives of the study reported here were to determine the knowledge, attitudes, and behaviors of large animal (dairy) veterinarians, dairy farmers, and dairy processors in Michigan, and to compare and contrast data from the large animal veterinarians, dairy farmers, and dairy processors according to the knowledge, attitude, and behavior variables. To accomplish these objectives, a cross-sectional epidemiologic study was designed.

The use of BST in the dairy industry is highly controversial. Bovine somatotropin is a natural protein hormone composed of approximately 190 amino acids,[1] is manufactured through recombinant DNA technology, and when injected into dairy cows, can increase milk production by 10 to 25%.[2] It increases milk production by altering the partitioning of nutrients, sparing the utilization of glucose and amino acids in synthesis of milk components and promoting the utilization of fatty acids as an energy source.[3]

The hormone is regulated by the FDA from three safety aspects: target animal safety, human food safety, and environmental impact.[4] Juskevich and Guyer[5] reported that so far, the FDA scientists concluded that the use of BST in dairy cattle presents no increased health risk to consumers. In addition, the National Institute of Health and Congressional Office of Technology Assessment have determined that BST is safe for human consumption and has no adverse health effects for the dairy cow.[1,6,7] Independent researchers have also concluded BST-treated cows did not have any adverse health effects.[8,9,10] They reported BST-treated cows were similar to high-producing dairy cows in metabolic processes and homeostatic mechanisms to the point that high-producing cows may serve as models for predicting health and nutrient requirements for BST-treated cows.[10,11,12] However, FDA approval of general use of BST is still pending, awaiting further information on target animal safety and environmental safety.

Ms. Shaw is a third year veterinary student at Michigan State University. From the Departments of Large Animal Clinical Sciences of the College of Veterinary Medicine (Mather) and Family Practice of the College of Human Medicine (Noel), Michigan State University, East Lansing, MI 48824.

This study was supported in part by a National Institute of Health Biomedical Summer Research Program grant. The authors thank Anne Woodard, Diane Leslie, MaryEllen Shea, and Debbie Richardson for technical assistance, and Dr. John B. Kaneene for statistical advice.

Proponents of BST use claim that use of BST increases milk production and feed efficiency, leading to a decrease in milk production costs.[2] Therefore, it should increase the overall efficiency of dairy operations.

It has been stated that an efficient farmer can cut operating costs by using the hormone, because fewer cows are needed to produce the same amount of milk.[13] In addition to increased farm efficiency, increased milk production may also decrease the price of milk on the supermarket shelf for the consumer.[5]

The FDA approval of BST is a small step, compared with the preparation society needs to face the implications of the use of BST. The big step is the preparation of an information infrastructure.[14] McGuirk et al[2] concluded from their consumer survey that because of concerns such as the creation of an even greater milk surplus, loss of dairy farmers and decreased consumption of dairy products by consumers with the introduction of BST, veterinarians, agricultural scientists, and production economists will need to be proactive rather than reactive in planning strategies to prepare for FDA approval of BST. In other words, information science must keep pace with biotechnology.[14]

Methods

A written questionnaire was designed to assess the three variables of this study, knowledge, attitudes, and behaviors for veterinarians, dairy farmers, and dairy processors. A separate questionnaire was designed for each group. Each questionnaire had a similar format to allow for comparison and contrast between the groups. Initial questions asked for demographic information and were followed by questions based on knowledge, attitude, and behavior.

Three basic types of questions were asked of each group: (1) how much do you know about BST? (knowledge-based question), (2) what do you think about BST? (attitude-based question), and (3) how would you use BST or use dairy products produced with BST biotechnology (behavior-based question)? A cover letter accompanied each questionnaire. The study was approved by the University Committee on Research Involving Human Subjects at Michigan State University. The questionnaire was pretested with large animal (dairy) clinicians and students with a dairy background at the College of Veterinary Medicine at Michigan State University.

A representative sample of 1,000 dairy farmers was randomly selected by Michigan Agricultural Statistical Service from approximately 5,000 dairy farmers in Michigan. Mailing addresses for all 246 veterinarians involved in dairy practice in Michigan were provided by the Michigan Veterinary Medical Association (MVMA). This list included MVMA members and potential members. The potential member category included past members, new graduates, and veterinarians new to the state of Michigan.

Veterinarians selected for the sample were classified as food animal practitioners or mixed animal practitioners by the MVMA. Most of them (71.2%) were mixed small animal/equine/food animal practitioners. The remaining veterinarians were food animal (9.3%), small animal/food animal (13.8%), and equine/food animal (5.7%) practitioners.

Mailing addresses for all 55 dairy processors in Michigan were provided by the Michigan Agricultural Statistical Service and the Michigan Dairy Foods Association. Total dairy farmers surveyed was 989. Total veterinarians surveyed was 245. The overall number receiving the survey was 1,289.

Questionnaires, cover letters, and self-addressed stamped return envelopes were mailed to the survey population on June 15, 1991. Approximately one month later, reminder cards were sent to everyone. A month later, reminder cards were sent again to only the dairy processors, because their return rate was low for such a small group. Cost prohibited sending reminder cards again to dairy farmers and veterinarians. The data received were entered into a Lotus spreadsheet program, organized, and summarized.

The knowledge variable of the study was defined as specific information about BST.[15] Knowledge questions were phrased either as a statement or a question and three responses could be chosen—yes, no, or I don't know. For example, a knowledge question was, "Is BST normally found in the blood of a dairy cow?"

Attitude was defined as a state of mind or feelings with regard to BST.[15] Attitude questions contained the verbs "think" or "believe" or the phrase "change your mind." For example, one attitude question was, "Do you think milk produced through the use of BST biotechnology in dairy herds is safe for human consumption?"

Behavior was defined as actions or reactions of persons or things under specified circumstances with respect to BST.[15] Behavior questions contained the verbs "use," "drink," "promote," "recommend," and "offer." For example, a behavior question used was "Will you drink milk produced with BST biotechnology?"

Results and Discussion

Response rates for veterinarians, dairy farmers, and dairy processors were 55.1%, 34.9%, and 32.7%, respectively. Although greater response rates are desirable, these response rates are typical of similar questionnaires. Because the data represent a sizeable number of respondents (498) from a single geographic region, the results contribute to a meaningful and important study.

Demographics—Seventy-nine percent of dairy farmers that responded to the questionnaire were

Table 1—Sample demographic characteristics

Variable	Dairy farmers n = 345 (%)		Veterinarians n = 135 (%)		Dairy processors n = 18 (%)	
Age (years)	a	b	a	c	a	d
<30	5.5	2.8	5.2	6.4	16.7	
30 to 39	25.8	20.2	37.8	36.1	11.1	
40 to 49	28.4	26.9	34.8	33.9	22.2	NA
50 to 59	20.0	27.5	14.1	13.3	22.2	
>59	13.6	22.6	7.4	10.3	22.2	
Gender						
M	88.1		88.1	86.2	94.4	
F	4.9	NA	11.1	13.8	5.6	NA

n = total number responding to survey.

a = analysis of sample population in study; b = Michigan dairy farmers.[19] c = Michigan Veterinary Medical Association 1990 data of Michigan Veterinarians; d = No corresponding total population identified.

NA = data not available.

Table 2—Response to questions testing knowledge of bovine somatotropin (BST)

Question	Dairy farmers n = 345 (% correct)	Veterinarians n = 135 (% correct)	Dairy processors n = 18 (% correct)
Is BST normally found in the blood of a dairy cow? (Yes)	55.9	74.1	44.4
Can BST effectively be given by mouth to dairy cows? (No)	38.3	64.4	22.2
BST is produced by the posterior pituitary and regulated by somatostatin. (No)	1.7	13.3	0
BST has been shown to be active in human beings. (No)	22.3	54.8	22.2

n = total number responding to survey.

*Table 3—Situations that would cause respondents to change their mind about the use of BST**

Situation	Dairy farmers n = 345 (%)	Veterinarians n = 135 (%)	Dairy processors n = 18 (%)
Consumers' acceptance of BST	24.1	40.5	100.0
Acceptance of BST becoming an economic necessity	26.5	43.2	40.0
New information is released on product safety	16.9	43.2	80.0

*Responses to the question: If you would change your mind about the use of BST, what are the situations that would cause you to change your mind?

n = total number responding to survey.

owners or operators of the dairy farm (Table 1). In addition, 40% of veterinarians spent 51 to 100% of their time on dairy-related activities. Despite the sampling method, which aimed at targeting large animal (dairy) veterinarians, 29% of the respondents spent 0 to 10% of their time on dairy-related activities.

Knowledge—Veterinarians scored the highest overall on the knowledge questions, followed by dairy farmers, and then dairy processors (Table 2). The question stating, "BST is produced by the posterior pituitary and regulated by somatostatin," was intended to be the most difficult question. Dairy farmers and dairy processors were not expected to answer this question correctly because most lack training in physiology. Veterinarians, however, because of their training, were expected to correctly answer this question. Yet, only 13% of veterinarians correctly answered this question.

Attitudes—As a follow-up to the question on the use of BST, dairy farmers were asked what situations would cause them to change their minds about use of BST. The most prevalent one is a change in the milk surplus or the price of milk (37%). If there was no longer a milk surplus or if there was a need for increased milk production, dairy farmers would be more likely to adopt use of BST.

Likewise, if the price of milk increased, dairy farmers would be more likely to adopt use of BST. This response may reflect the low price for milk during the summer of 1991.

Twenty-six percent of dairy farmers reported they would accept use of BST if it became an "economic necessity." These farmers would adopt use of BST to remain competitive in the milk market. On the other hand, 25% of dairy farmers responded there are no situations that would cause them to change their minds about BST. These farmers would not use BST no matter what the situation.

In addition, 24% of dairy farmers would change their mind about BST if consumers accept the use of BST in dairy products. Furthermore, 17% of dairy farmers would change their mind about BST if new information on product safety was released (Table 3).

Several situations would cause veterinarians to change their minds about BST: the release of new data on the safety of the use of BST (43%); if farmers needed to use BST to remain competitive in the milk market, some veterinarians would be more likely to recommend it (43%); and 40% would recommend it if consumer consumption of dairy products did not change with the use of BST (Table 3).

All the processors surveyed said consumer acceptance would change their views about BST use. If consumer consumption of dairy products did not change with the use of BST, dairy processors would use milk produced with BST biotechnology in their dairy plants. New information on product safety (80%) and government regulation of BST (80%) were also situations that would cause dairy processors to change their minds (Table 3).

Veterinarians, followed by dairy processors, then dairy farmers, were confident use of BST in milk production is safe for human consumption. Likewise, veterinarians, followed by dairy farmers, then dairy processors, were confident use of BST is safe for dairy cows. Dairy processors and veterinarians who said they were not comfortable with

Table 4—Response to questions testing attitudes towards BST

Question	Dairy farmers n = 345 (% yes)	Veterinarians n = 135 (% yes)	Dairy processors n = 18 (% yes)
Do you think milk produced through the use of bovine somatotropin (BST) in dairy herds is safe for human consumption?	40.9	71.1	64.7
Do you think the use of BST is safe for your dairy cows?	33.6	66.7	27.8
If your answer was no to using or recommending BST, or using milk produced through BST biotechnology, are there any situations that would cause you to change your mind?	24.1	27.4	27.8
Should BST be given Food and Drug Administration approval as a scientifically safe product?	30.7	59.3	33.3

n = Total number responding to survey.

Table 5—Positive responses to behavior questions

Question	Dairy farmers n = 345 (%)	Veterinarians n = 135 (%)	Dairy processors n = 18 (%)
Would you use BST in your dairy herd?	24.1	...	...
Would you recommend the use of BST to the dairy herds you serve?	...	50.4	...
Would you use BST-produced milk in the dairy products you process?	...	...	44.4
Will you drink milk produced through BST biotechnology?	39.4	73.3	72.2

n = Total number responding to survey.

Table 6—Variables that would be positively considered in the use of BST*

Conditions or circumstances	Dairy farmers n = 345	Veterinarians n = 135
Body condition score	57.8	79.4
Reproductive status	51.8	48.5
6 weeks after calving	32.5	39.7
Age	16.8	17.6
Use on all cows	9.6	10.3
High butterfat cows	8.4	4.4
Top-producing cows only	8.4	13.2
4 to 6 weeks after calving	9.6	14.7
2 weeks after calving	6.0	7.3

*Responses to question: How would you use BST (dairy farmers) or How would you recommend the use of BST to the dairy herds you serve (veterinarians)?

BST-use indicated a greater willingness to change their minds about BST than did dairy farmers (Table 4).

Behavior—Twenty-four percent of dairy farmers responded that they would use BST (Table 5). Thirty-nine percent stated they would drink milk produced with BST biotechnology. Only 21% said they would promote the use of BST in their dairy cooperative. Further studies are needed to understand or explain these responses to the behavior questions and to determine whether the trends are changing.

Dairy farmers would want to select cows for BST use primarily on their condition score and reproductive status. They favored six weeks after calving as the stage in the lactation cycle to use BST. This corresponds to Weaver's recommendation that treatment be delayed until after the usual period of postpartum energy deficits.[16] This period is approximately six weeks after calving.[17] Other conditions in which dairy farmers would use BST included: 90 to 100 days after calving and under the direction of a veterinarian, a feed consultant, or the manufacturer. Also, use of BST would depend on the economic factors of the situation (Table 6).

The foremost reason why farmers would never use BST is because they think there is already too much milk. This corresponds to Schmidt's suggestion that low milk prices and high feed prices would not be conducive to the use of BST.[18] With the low prices for milk in the summer of 1991, farmers did not see a need for increased milk production. The second most frequently stated reason was the use of BST will place too much stress on the cows. Farmers said increasing milk production through use of BST will stress cows, leading to further health complications. The third most frequent response of dairy farmers was that BST is not natural. This response indicated farmers simply did not subscribe to the idea of injecting cows with BST to increase milk production.

Fifty percent of veterinarians responded that they would recommend use of BST. Seventy-three percent said they would drink milk produced with BST biotechnology (Table 5). In addition, 38% of veterinarians would offer BST for sale if it was available as a nonprescription product. However, 45% would not offer BST for sale under that circumstance. Of those who would not offer BST for sale as an over-the-counter drug, 24% would recommend the purchase of BST from another source.

Veterinarians would recommend use of BST six weeks after calving and select cows for BST use on the basis of condition score and reproductive status. Other recommendations suggested by veterinarians included the use of BST 80 to 100 days after calving, nonuse of BST on sick cows, and the use of BST according to the manufacturer's recommendation (Table 6).

The most important criteria veterinarians would use to recommend BST were the management abilities of the farmers, health of the herd, scientific skills of the farmer, and economic viability of the herd/farm (Table 7). According to the veterinarians in this study, dairy farmers with excellent management skills, strong scientific skills, healthy herds, and financially stable businesses were the strongest candidates for the use of BST. Another criterion mentioned by veterinarians was the nutritional status of the herd.

It has been suggested that quality of management will be the major factor affecting the magni-

Table 7—Criteria veterinarians would use in recommendation of BST *use* (n = 135)*

Criteria	Response (%)
Management abilities	74.1
Health of herd	65.2
Scientific skills of farmer	52.6
Economic viability of herd/farmer	49.6
Pounds of milk produced/year	32.6
Quality of milk	25.2
Other	16.3
Size of herd	13.3
No criteria	8.9

*Responses to the question: What are the criteria you would use to make a recommendation to use BST?

tude of response.[17] The magnitude of the response to BST is dependent on the managerial skills of the dairy farmer. Therefore, excellent managers should receive the greatest response from the use of BST in their dairy herds.[17]

Other factors to be considered in determining whether BST should be used in a particular herd included owner bias, management capabilities, herd genetics, production history, feedstuffs available, and herd records.[16] In addition, practitioner involvement will be critical in ensuring that expected responses to treatment are observed and in identifying and discriminating among successful BST management strategies.[16]

Therefore, it is suggested that practitioners who are proactive and informed about BST will better fulfill their role as production consultants to the dairy farmer.[16] It has been further suggested that if recombinant BST is adopted, veterinarians will need to discuss new approaches to herd management.[8] Some of these new approaches are an enhanced understanding of dairy nutrition to meet the needs of high-producing dairy cows given BST, rigorous reproductive programs to account for the possibility of impaired fertility, and strong economic background to provide sound advice and services to farms that used BST.[8]

Veterinarians and other agricultural scientists must be prepared for the impact of the impending BST technology. In an economic survey it was determined that BST will be an economic alternative for dairy farmers who have the ability to feed and manage higher producing dairy cows.[18]

Veterinarians who would never recommend use of BST stated the following reasons: excessive surplus milk supplies, concern over decreased consumer consumption of dairy products, concern that milk production with BST use is not natural, concern that more information on product safety is needed, and concern that farmers needed to have better management skills.

Dairy processors who would never use milk produced through BST biotechnology would do so for only one reason, decreased consumer consumption of dairy products. These respondents stated consumers do not want milk produced through BST biotechnology and recognize the potential consumer rejection of dairy products that contain milk produced with BST biotechnology.

Veterinarians were more positive about the use of BST than dairy processors and dairy farmers. Veterinarians and dairy processors were far more likely to drink milk produced with BST biotechnology than were dairy farmers. Dairy farmers and veterinarians agreed the most important determinants for use of BST were the condition score, the reproductive status of the dairy cow, and a time period beginning six weeks after calving.

Dairy farmers against the use of BST were primarily driven by the price of milk. Veterinarians against the use of BST were concerned about milk supply and consumer reaction. Dairy processors against the use of BST were also primarily concerned about a negative consumer reaction.

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September 1, 1992, Volume 201, Number 5

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Vol 201 September 1, 1992 No. 5
JAVMA 201 (5) 657-824 (1992)
ISSN 0003-1488

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SUBSCRIPTIONS: For one year: members $50, others $100 in the United States and possessions; $120 in foreign countries. Single copies: $6 in the United States and possessions; $8 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

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BPA

The Information Exchange

Demographic and employment shifts of US veterinarians, 1980 to 1990

The Center for Information Management was commissioned by the AVMA Executive Board to conduct an analysis of the US population of veterinarians, regarding demographic, geographic, and employment variables. The purpose of the analysis was to develop a profile of the profession, including demographic and employment shifts taking place in the profession in recent years. With the establishment of this analysis as part of the Center's ongoing research programs, the veterinary medical profession will benefit from a clearer picture of past trends and be able to determine its future course with greater confidence.

Data used for analysis were obtained from the computer master file of veterinarians, which is maintained by the Division of Membership and Field Services. The file represented the best available data base of veterinarians and associated demographic information for the years 1980, 1990, and 1991. The AVMA records include all US graduates, beginning in 1980, when the association began to initiate records for all US veterinary students and track them through graduation.

The 1991 AVMA master file included 65,767 veterinarians: 52,183 AVMA members, 3,141 verified nonmembers, and 10,443 unverified nonmembers. The combined population of members and verified nonmembers was 55,324 veterinarians. Excluding 777 veterinarians in foreign countries, 4,001 retired veterinarians, and 373 disabled or inactive veterinarians, the population of active veterinarians in the United States was 50,173 veterinarians. This figure was used as the base population for 1991 tabulations. A similar breakdown of the 1980 and 1990 AVMA master files yielded populations of 32,734 and 48,666 active veterinarians, respectively.

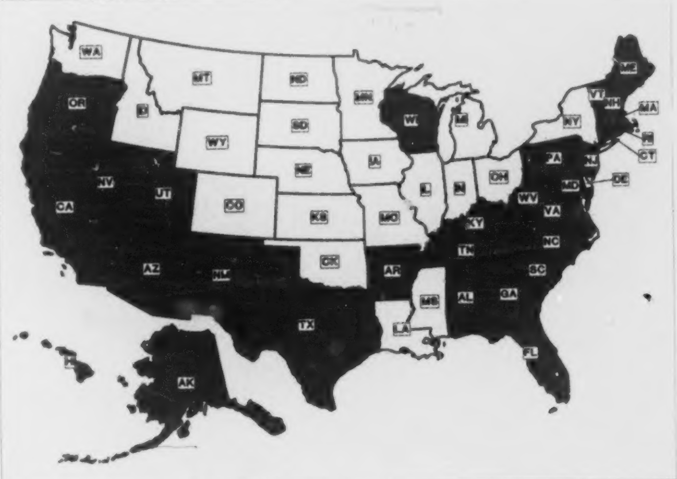

Figure 1—Percentage change of veterinarians, 1980 to 1990. ☐ *≤ average (48.7%);* ■ *> average (48.7%).*

On the basis of analysis of the 1980, 1990, and 1991 AVMA computer master files of Association members and verified nonmembers, the population of active veterinarians in the United States increased 48.7%, from 32,734 in 1980 to 48,666 in 1990, or about 4% per year compounded annually. In 1991, the total number of active veterinarians was estimated to be 50,173, up 3% from 1990.

Geography

The percentage increase in veterinarians from 1980 to 1990 varied among 9 census regions of the country (Table 1). In general, growth was greater than average in the southwestern and southeastern states, and less than average in north-central and western mountain states (Fig 1). The West North Central region had the lowest growth rate (27.4%)

From the AVMA Center for Information Management; J. Karl Wise, PhD, Director; Jih-Jing Yang, PhD, Research Analyst.

Table 1—Veterinarians by state, 1980, 1990, 1991

State	1980		1990		1991		Change 1980 to 1990	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Total	32,734	100.0	48,666	100.0	50,173	100.0	15,932	48.7
New England	1,333	4.1	2,319	4.8	2,398	4.8	986	74.0
Maine	146	0.4	240	0.5	247	0.5	94	64.4
New Hampshire	141	0.4	256	0.5	264	0.5	115	81.6
Vermont	119	0.4	198	0.4	208	0.4	79	66.4
Massachusetts	512	1.6	942	1.9	973	1.9	430	84.0
Rhode Island	59	0.2	110	0.2	107	0.2	51	86.4
Connecticut	356	1.1	573	1.2	599	1.2	217	61.0
Middle Atlantic	3,551	10.8	5,382	11.1	5,542	11.0	1,831	51.6
New York	1,582	4.8	2,336	4.8	2,396	4.8	754	47.7
New Jersey	744	2.3	1,159	2.4	1,174	2.3	415	55.8
Pennsylvania	1,225	3.7	1,887	3.9	1,972	3.9	662	54.0
East North Central	5,982	18.3	8,077	16.6	8,278	16.5	2,095	35.0
Ohio	1,397	4.3	1,876	3.9	1,905	3.8	479	34.3
Indiana	922	2.8	1,148	2.4	1,160	2.3	226	24.5
Illinois	1,482	4.5	1,964	4.0	2,023	4.0	482	32.5
Michigan	1,293	4.0	1,663	3.4	1,704	3.4	370	28.6
Wisconsin	888	2.7	1,426	2.9	1,486	3.0	538	60.6
West North Central	4,345	13.3	5,535	11.4	5,719	11.4	1,190	27.4
Minnesota	871	2.7	1,231	2.5	1,274	2.5	360	41.3
Iowa	1,121	3.4	1,203	2.5	1,238	2.5	82	7.3
Missouri	907	2.8	1,197	2.5	1,234	2.5	290	32.0
North Dakota	125	0.4	135	0.3	144	0.3	10	8.0
South Dakota	204	0.6	248	0.5	251	0.5	44	21.6
Nebraska	448	1.4	586	1.2	613	1.2	138	30.8
Kansas	669	2.0	935	1.9	965	1.9	266	39.8
South Atlantic	4,784	14.6	8,439	17.3	8,751	17.4	3,655	76.4
Delaware	80	0.2	109	0.2	128	0.3	29	36.3
Maryland	763	2.3	1,242	2.6	1,276	2.5	479	62.8
Virginia	719	2.2	1,353	2.8	1,408	2.8	634	88.2
District of Columbia	72	0.2	79	0.2	74	0.1	7	9.7
West Virginia	133	0.4	201	0.4	198	0.4	68	51.1
North Carolina	649	2.0	1,352	2.8	1,417	2.8	703	108.3
South Carolina	255	0.8	442	0.9	463	0.9	187	73.3
Georgia	749	2.3	1,227	2.5	1,279	2.5	478	63.8
Florida	1,364	4.2	2,434	5.0	2,508	5.0	1,070	78.4
East South Central	1,905	5.8	2,936	6.0	3,012	6.0	1,031	54.1
Kentucky	501	1.5	776	1.6	794	1.6	275	54.9
Tennessee	561	1.7	904	1.9	917	1.8	343	61.1
Alabama	538	1.6	837	1.7	874	1.7	299	55.6
Mississippi	305	0.9	419	0.9	427	0.9	114	37.4
West South Central	3,745	11.4	5,523	11.3	5,665	11.3	1,778	47.5
Arkansas	304	0.9	455	0.9	460	0.9	151	49.7
Louisiana	516	1.6	745	1.5	762	1.5	229	44.4
Oklahoma	623	1.9	892	1.8	895	1.8	269	43.2
Texas	2,302	7.0	3,431	7.1	3,548	7.1	1,129	49.0
Mountain	2,389	7.3	3,487	7.2	3,592	7.2	1,098	46.0
Montana	241	0.7	295	0.6	292	0.6	54	22.4
Idaho	259	0.8	325	0.7	329	0.7	66	25.5
Wyoming	128	0.4	158	0.3	166	0.3	30	23.4
Colorado	840	2.6	1,144	2.4	1,196	2.4	304	36.2
New Mexico	203	0.6	354	0.7	362	0.7	151	74.4
Arizona	424	1.3	706	1.5	731	1.5	282	66.5
Utah	158	0.5	241	0.5	253	0.5	83	52.5
Nevada	136	0.4	264	0.5	263	0.5	128	94.1
Pacific	4,524	13.8	6,737	13.8	6,977	13.9	2,213	48.9
Washington	826	2.5	1,163	2.4	1,230	2.5	337	40.8
Oregon	472	1.4	707	1.5	739	1.5	235	49.8
California	3,048	9.3	4,588	9.4	4,710	9.4	1,540	50.5
Alaska	77	0.2	124	0.3	133	0.3	47	61.0
Hawaii	101	0.3	155	0.3	165	0.3	54	53.5
Possessions	176	0.6	231	0.5	239	0.5	55	31.3
Puerto Rico	57	0.2	104	0.2	109	0.2	47	82.5
Other Possessions	119	0.4	127	0.3	130	0.3	8	6.7

Table 2—Veterinarians by primary employment, 1980, 1990, 1991

	1980		1990		1991		Change 1980 to 1990	
Primary employment	**No.**	**Percentage**	**No.**	**Percentage**	**No.**	**Percentage**	**No.**	**Percentage**
Total	32,268	100.0	45,755	100.0	46,814	100.0	13,487	41.8
Private clinical	25,499	100.0	36,828	100.0	37,615	100.0	11,329	44.4
Large animal exclusive	1,177	4.6	1,657	4.5	1,698	4.5	480	40.8
Large animal predominant	4,424	17.3	4,271	11.6	4,199	11.2	(153)	−3.5
Mixed animal	2,582	10.1	3,211	8.7	3,159	8.4	629	24.4
Small animal predominant	4,148	16.3	5,087	13.8	5,148	13.7	939	22.6
Small animal exclusive	11,724	46.0	19,921	54.1	20,614	54.8	8,197	69.9
Equine exclusive	1,032	4.0	1,641	4.5	1,634	4.3	609	59.0
Other	412	1.6	1,040	2.8	1,163	3.1	628	152.4
Public and corporate	6,769	100.0	8,927	100.0	9,199	100.0	2,158	31.9
College or university	2,849	42.1	4,393	49.2	4,438	48.2	1,544	54.2
Federal government	1,133	16.7	1,137	12.7	1,201	13.1	4	0.4
State or local government	665	9.8	704	7.9	717	7.8	39	5.9
Uniformed services	614	9.1	533	6.0	533	5.8	(81)	−13.2
Industry	868	12.8	1,236	13.8	1,310	14.2	368	42.4
Other	640	9.5	924	10.4	1,000	10.9	284	44.4

from 1980 to 1990. For the same period, the South Atlantic and New England regions had growth rates of 76.4 and 74%, respectively. As a result, South Atlantic replaced East North Central as the region with the most veterinarians.

North Carolina had the highest growth rate (108.3%) from 1980 to 1990. Iowa and North Dakota increased by 8.0% or less over the 10-year period. California had the largest population of veterinarians, with approximately 10% of the total in the nation. More than 26% of veterinarians were located in California, Texas, Florida, and New York combined.

Gender

From 1980 to 1990, more females than males entered veterinary medicine. The number of female veterinarians increased 288%, from 3,212 in 1980 to 12,462 in 1990, while male veterinarians increased only 24%, from 29,288 in 1980 to 36,204 in 1990 (Fig 2).

In 1980, approximately 90% of veterinarians were male, and 10% were female. In 1990, nearly 26% of veterinarians were female, and 74% were male. That is, in just over 10 years, the proportion of females increased from 1 of 10 to 1 of 4 veterinarians.

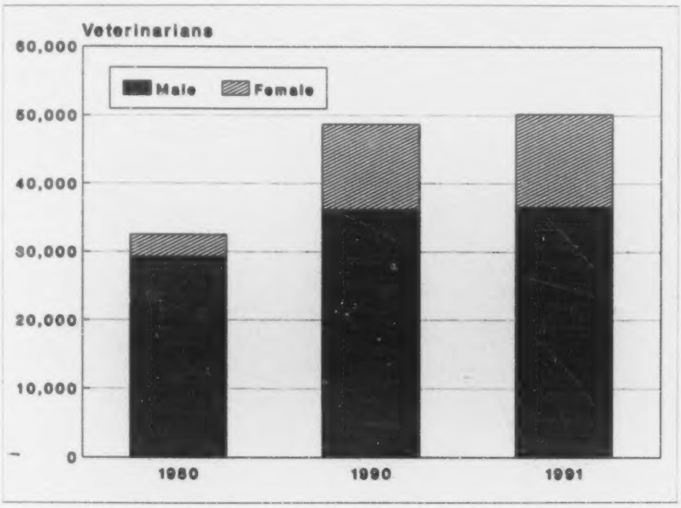

Figure 2—Veterinarians by gender, 1980, 1990, 1991.

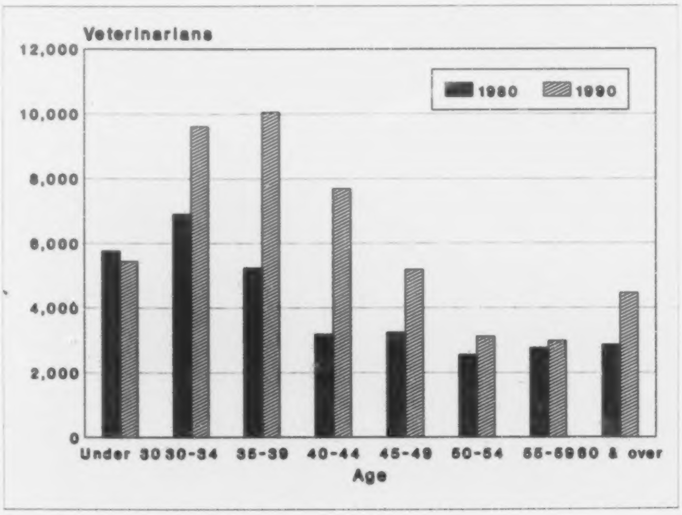

Figure 3—Veterinarians by age, 1980, 1990.

Age

The median age of active veterinarians was 39 in 1990, compared with 38 in 1980. This means that one half of the active veterinarians were younger than 39 years old, and one half were older. With the exception of the under-30 age group, the number of active veterinarians increased among age groups from 1980 to 1990 (Fig 3).

Primary Employment

In 1990, 80% of veterinarians were engaged in private clinical practice as a practice owner or as an associate of a private practice (Table 2). Twenty percent of veterinarians worked in public or corporate employment. This compared with 79% in private clinical practice and 21% in public and corporate employment in 1980.

Nearly 20,000 veterinarians were in small animal exclusive practice in 1990, up nearly 70% from 1980 (Fig 4). The number of equine practitioners increased by 59% over the 10-year period. While the number of large animal exclusive practitioners increased at least 40%, the population of mixed animal and small animal predominant practitioners grew slowly, in the 22 to 26% range. The number of large animal predominant practitioners declined from 1980 to 1990.

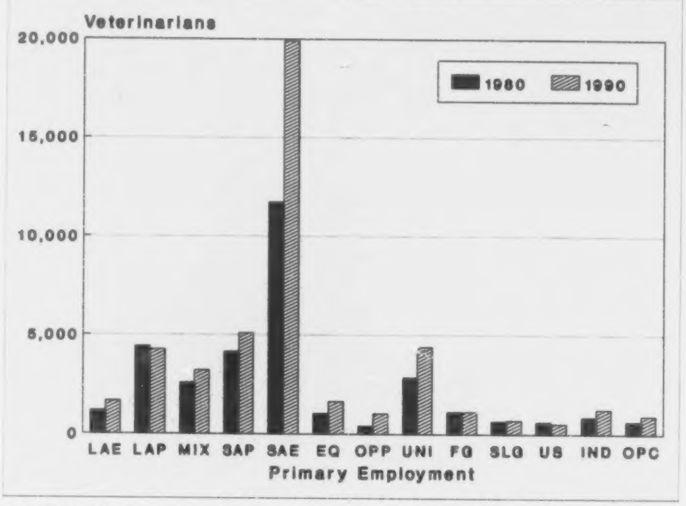

Figure 4—Veterinarians by primary employment, 1980, 1990. LAE *= large animal exclusive;* LAP *= large animal predominant;* MIX *= mixed animal;* SAP *= small animal predominant;* SAE *= small animal exclusive;* EQ *= equine;* OPP *= other private practice;* UNI *= university;* FG *= federal government;* SLG *= state or local government;* US *= uniformed services;* IND *= industry;* OPC *= other public and corporate.*

In public or corporate employment, college/university and industry sectors showed solid growth of 54 and 42%, respectively. Employment in the federal government was stable, and employment in the uniformed services declined slightly from 1980 to 1990.

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September 15, 1992, Volume 201, Number 6

JOURNAL

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JOURNAL
OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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JAVMA 201 (6) 825-960
ISSN 0003-1488

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About the cover

Beverly Wende used acrylics to paint *Miss Molly Magic* in 1991. Mrs. Wende has been an office manager and receptionist for a small animal clinic in Canton, Georgia for the past 10 years. She studied art at the Ringling School of Art in Sarasota, Florida, and has been painting wildlife, landscapes, and animal portraits for the past 16 years.

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Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

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The Information Exchange

Distribution of US veterinarians by gender, 1980 to 1990

The Executive Board of the AVMA commissioned the Center for Information Management to conduct a study of the demographic, geographic, and employment trends of US veterinarians. The study included a comprehensive analysis of the AVMA computerized membership master files from 1980, 1990, and 1991.

It has been reported that, from 1980 to 1990, more females than males entered veterinary medicine.[1] The percentage of female veterinarians increased from 10% in 1980 to 25% in 1990. To better understand the veterinary medical profession, it is useful to examine and compare the demographic characteristics of the profession regarding gender. Several demographic variables, including primary employment, year of graduation, age at graduation, and age were further analyzed, and summary results are presented here.

Primary Employment

Analysis of gender and primary employment was made on the basis of member and nonmember records that included current type of employment and professional medical activity. Of the 32,037 US veterinarians known to be actively employed in 1980, females comprised 9.5% of veterinarians in private clinical practice and 9.5% of veterinarians in public and corporate employment (Table 1). By 1990, of the 45,755 active US veterinarians, the percentage of females in private clinical practice had increased to 23.8%, and the percentage of females in public and corporate employment also had increased to 23.8%.

Table 1—Veterinarians by primary employment by gender, 1980, 1990

	1980			1990		
Primary employment	**Female (%)**	**Male (%)**	**No.**	**Female (%)**	**Male (%)**	**No.**
Total	9.5	90.5	32,037	23.8	76.2	45,755
Private clinical	9.5	90.5	25,371	23.8	76.2	36,828
Large animal exclusive	3.6	96.4	1,165	9.4	90.6	1,657
Large animal predominant	3.6	96.4	4,389	8.7	91.3	4,271
Mixed animal	8.6	91.4	2,576	18.6	81.4	3,211
Small animal predominant	10.3	89.7	4,126	22.4	77.6	5,087
Small animal exclusive	12.3	87.7	11,682	29.8	70.2	19,921
Equine exclusive	8.9	91.1	1,027	19.1	80.9	1,641
Other	7.4	92.6	406	25.3	74.7	1,040
Public and corporate	9.5	90.5	6,666	23.8	76.2	8,927
College or university	14.1	85.9	2,832	28.6	71.4	4,393
Federal government	4.8	95.2	1,095	18.7	81.3	1,137
State or local government	4.2	95.8	641	16.6	83.4	704
Uniformed services	5.2	94.8	613	14.4	85.6	533
Industry	4.6	95.4	864	15.0	85.0	1,236
Other	13.2	86.8	621	30.2	69.8	924

Table 2—Veterinarians by age by gender, 1980, 1990

	1980			1990		
Age	**Female (%)**	**Male (%)**	**No.**	**Female (%)**	**Male (%)**	**No.**
Total	9.9	90.1	32,424	25.6	74.4	48,525
< 30	29.3	70.7	5,757	51.8	48.2	5,444
30 to 34	13.1	86.9	6,902	46.0	54.0	9,613
35 to 39	5.9	94.1	5,227	33.3	66.7	10,050
40 to 44	4.2	95.8	3,176	15.8	84.2	7,691
45 to 49	1.9	98.1	3,233	7.0	93.0	5,183
50 to 54	1.7	98.3	2,536	5.0	95.0	3,112
55 to 59	1.5	98.5	2,743	2.0	98.0	2,973
≥ 60	0.9	99.1	2,850	1.5	98.5	4,459
Median age (yrs)	29	39	. . .	33	42	. . .

The increase in female veterinarians varied among specific types of private clinical practice (Table 1). Small animal exclusive practice and college and university employment had higher than average proportions of female veterinarians. In contrast, large animal exclusive and large animal predominant practice types employed less than average proportions of female veterinarians.

Analysis of the distribution of female veterinarians revealed that approximately 65% of females worked in small animal predominant and small animal exclusive practices. Ten percent of female veterinarians worked in academia. The remaining 25% were distributed among the other types of clinical practice and public or corporate employment. According to AVMA records, while the number of female veterinarians

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From the AVMA Center for Information Management; J. Karl Wise, PhD, Director; Jih-Jing Yang, PhD, Research Analyst.

Table 3—Veterinarians by year of graduation by gender, 1990

Year of graduation	Female (%)	Male (%)	No.
Total	25.6	74.4	48,666
Prior to 1960	1.7	98.3	5,832
1960 to 1964	3.0	97.0	3,318
1965 to 1969	5.3	94.7	4,380
1970 to 1974	8.7	91.3	5,636
1975 to 1979	21.7	78.3	7,328
1980 to 1984	36.9	63.1	9,636
1985 to 1989	49.6	50.4	10,500
1990 to 1991	58.1	41.9	2,036

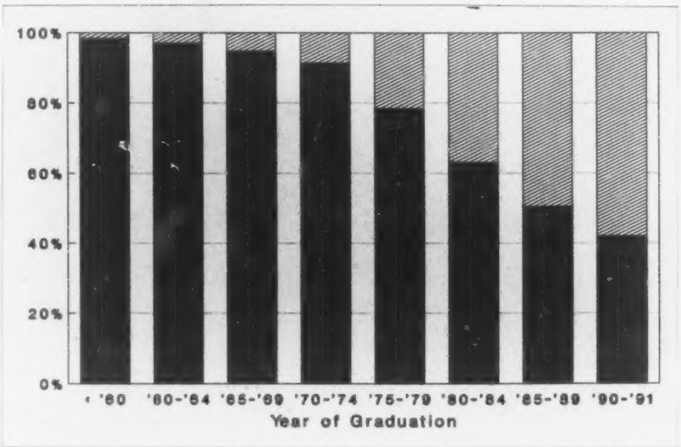

Figure 1—Percentage of veterinarians by year of graduation by gender, 1990. ■ = male; ▨ = female.

Table 4—Veterinarians by year of graduation by age at graduation, 1991

Year of graduation	Age of veterinarians at graduation					
	< 25 (%)	25 to 26 (%)	27 to 28 (%)	29 to 30 (%)	> 30 (%)	Total No.
Prior to 1970						
Female	52.3	26.0	9.8	4.1	7.9	419
Male	34.4	31.6	13.9	10.3	9.8	12,261
1970 to 1974						
Female	48.1	35.1	8.9	2.8	5.1	493
Male	31.2	43.1	12.8	5.9	6.9	5,131
1975 to 1979						
Female	24.6	46.0	15.1	7.3	7.0	1,585
Male	15.8	42.9	18.3	10.8	12.2	5,701
1980 to 1984						
Female	9.2	42.9	23.4	11.9	12.5	3,503
Male	6.6	39.0	26.0	13.1	15.2	6,061
1985 to 1989						
Female	3.3	37.6	25.4	12.9	20.8	5,219
Male	3.0	36.8	27.8	14.1	18.4	5,284
1990 to 1991						
Female	2.4	38.2	24.1	12.9	22.5	2,316
Male	2.0	38.5	29.6	12.2	17.7	1,729

increased from 1980 to 1990 in every type of primary employment, the number of male veterinarians decreased in large animal predominant practice, federal and state government, and uniformed services.

Age

In 1980, male veterinarians were the majority in all age groups (Table 2). Because more female veterinarians graduated after 1980, the composition of the profession changed. Males continued to represent a majority in the group over 35 years old in 1990. However, in the 34-year-old and younger age group, the proportion of males and females was approximately equal.

On the basis of the decrease in the number of males that entered the profession since 1980, the median age of male veterinarians increased from 39 years in 1980 to 42 years in 1990 (Table 2). On the other hand, the median age of female veterinarians increased from 29 years in 1980 to 33 years in 1990. Approximately 85% of female veterinarians were under 40 years old, compared with 52% of male veterinarians.

Year of Graduation

The proportion of females and males was analyzed by year of graduation from veterinary medical college. In 1990, among active veterinarians who graduated prior to 1960, the percentage of female veterinarians was 1.7% of veterinarians, compared with males, who represented 98.3% (Table 3, Fig 1). Among veterinarians who graduated in 1980 to 1984, 36.9% were females, and 63.1% were males. Among veterinarians who graduated in 1990 to 1991, 58.1% were females, and 41.9% were males.

Age at Graduation

Further analysis of gender and age at the time of graduation demonstrated that the age of veterinarians at graduation increased over time for males and females (Table 4).

Comparing females and males who graduated after 1985, higher proportions of females than males were over 30 years old at the time of graduation. Specifically, in the 1985 to 1989 group, 20.8% of females were over 30 years old at graduation, compared with 18.4% of males. In the 1990 to 1991 group, 22.5% of females were over 30 years old at graduation, compared with 17.7% of males.

Reference

1. Center for Information Management. Demographic and employment shifts of US veterinarians, 1980 to 1990. *J Am Vet Med Assoc* 1992;201:684–687.

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October 1, 1992, Volume 201, Number 7

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Vol 201 October 1, 1992 No. 7
JAVMA 201 (7) 961-1128 (1992)
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SUBSCRIPTIONS: For one year: members $50; others $100 in the United States and possessions; $120 in foreign countries. Single copies: $6 in the United States and possessions; $8 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

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BPA

The Information Exchange

Veterinary Service Market for Companion Animals, 1992

Part I: Companion animal ownership and demographics

This is the first of a 2-part series summarizing findings from the complete report available from the AVMA Center for Information Management. Veterinary service use and expenditures will be addressed in Part II in the next issue.

In November 1991, the Center for Information Management was commissioned by the Executive Board of the AVMA to conduct a nationwide study of US households to update, expand, and report information on the companion animal market for veterinary medical services.

The objectives of the study were to determine populations of dogs, cats, birds, horses, and other pets owned by US households; household demographic characteristics associated with pet ownership; and frequency of times that pets were seen by a veterinarian, and annual veterinary medical expenditures.

The veterinary service market survey for companion animals was conducted between January and March 1992. The survey questionnaire was mailed to 80,000 US households. Regarding survey response, 55,143 households (68.9%) returned usable survey questionnaires. The respondent group was analyzed, compared with the total population of households, and determined to be a representative sample of the population.

Companion Animal Ownership and Populations

On the basis of information provided by the nationally representative sample of 55,143 US households, it was estimated that 54.8 million households, 57.9% of all US households, owned a companion animal on Dec 31, 1991. For this study, companion animals included dogs, cats, birds, horses, and any of several other pets, such as hamsters, gerbils, fish, and rabbits.

Regarding dogs, approximately 34.6 million households owned a dog at year-end in 1991 (Table 1). This estimated population of dog-owning households was nearly unchanged from the 1987 estimate of 34.7 million households.[1] Nevertheless, on the basis of growth in the total number of US households, the percentage of households that owned dogs decreased from 38.2% in 1987 to 36.5% in 1991. In 1991, a mean of 1.52 dogs were owned per dog-owning household; thus, the dog population was estimated to be 52.5 million dogs, nearly unchanged from 52.4 million dogs in 1987.

In 1991, approximately 29.2 million (30.9%) households owned a cat, up slightly from 27.7 million (30.5%) households in 1987 (Table 1). On the basis of 1.95 cats owned per cat-owning household, the cat population was 57.0 million cats in 1991, an increase from 54.6 million cats in 1987.

Regarding birds, 5.4 million (5.7%) households owned a bird in 1991, nearly unchanged from 5.2 million (5.7%) in 1987 (Table 1). On the basis of 2.16 birds owned per bird-owning household,

From the AVMA Center for Information Management, J. Karl Wise, PhD, Director; Jih-Jing Yang, PhD, Research Analyst.

Table 1—Pet ownership and population, 1987, 1991

	Households that owned a pet				Mean No. of pets owned per household		Pet population (millions)	
	(%)		No. (millions)					
	1987	1991	1987	1991	1987	1991	1987	1991
Dogs	38.2	36.5	34.7	34.6	1.51	1.52	52.4	52.5
Cats	30.5	30.9	27.7	29.2	2.04	1.95	54.6	57.0
Birds	5.7	5.7	5.2	5.4	2.48	2.16	12.9	11.7
Horses	2.8	2.0	2.6	1.9	2.63	2.54	6.6	4.9
Other pets	...	6.7	...	6.3	...	...	...	...

Table 2—Percentage of pet owners that owned another pet, 1991

Primary pet	Dog	Cat	Bird	Horse
Dog	...	40.3	9.5	4.6
Cat	47.6	...	8.1	4.5
Bird	60.8	43.6	...	5.0
Horse	83.0	68.7	13.9	...

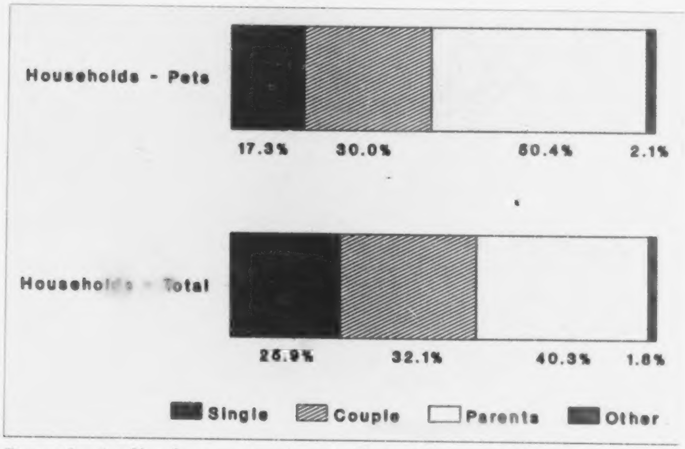

Figure 1—Profile of pet-owning households by life-stage, 1991.

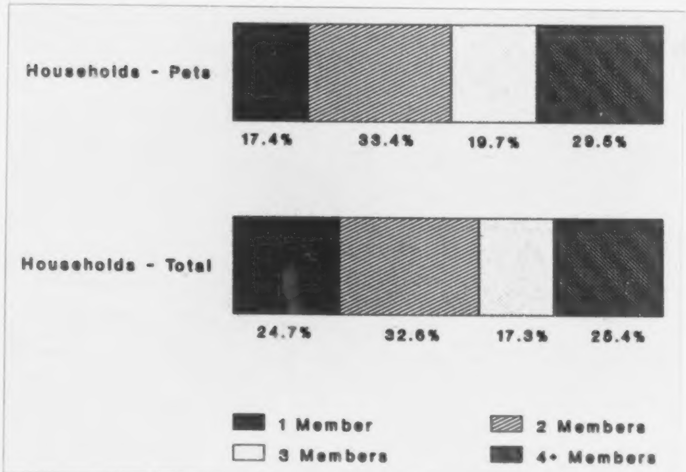

Figure 2—Profile of pet-owning households by household size, 1991.

the population of birds owned by households was 11.7 million birds, down from 12.9 million birds in 1987. The decrease may be attributable, in part, to a decrease in the mean number of birds owned per bird-owning household from 2.48 birds in 1987.

The estimated number of households that owned horses in 1991 was 1.9 million (2.0%), a decrease from 2.6 million (2.8%) in 1987 (Table 1). The 1991 population of horses owned by households was 4.9 million horses, down from 6.6 million horses in 1987. The mean number of horses owned per horse-owning household was 2.54 in 1991, a decrease from 2.63 in 1987.

Approximately 6.7% of US households owned other pets in 1991, including an estimated 24.0 million fish, 4.6 million rabbits, 1.3 million hamsters, 600,000 gerbils, and several million other household pets of various species.

Many households owned more than 1 type of pet. Table 2 shows the percentage of each type of pet-owning household that owned another type of pet. Approximately 40.3% of dog owners also owned a cat, and 47.6% of cat owners also owned a dog. Regarding horse owners, 83% of horse owners also owned a dog, and nearly 69% also owned a cat.

Pet Owner Profiles

An important objective of this study was to determine the demographic factors associated with pet ownership. Many demographic factors were studied, including employment, age of head of the household, and educational level. Four variables found to be particularly important were household life-stage, income, size of household, and home ownership.

Household life-stage is a method used to classify households on the basis of family composition. Life-stage categories of households were defined as follows: Single was 1-member household; Couple was multimember household and no children at home; Parent was multimember household with 1 or more children at home.

Figure 1 graphically contrasts the profile of pet-owning households with all households by life-stage groups.These data suggest that pet-owning households were more likely to be parental households with children than households with singles. On one hand, 50% of pet-owning households were parents, compared with 40% of all households in the country. On the other hand, 17% of pet-owning households were singles, compared with nearly 26% of all households.

Pet-owning households were more likely to be house-

Table 3—Profile of pet-owning households by household income, 1991

Household income	All households (%)	Pet-owning households (%)
<$12,500	18.7	15.0
$12,500 to $24,999	20.7	19.9
$25,000 to $39,999	22.4	23.5
$40,000 to $59,999	20.0	21.8
≥$60,000	18.2	19.9

Table 4—Profile of pet owning households by home ownership, 1991

Home ownership	All households (%)	Pet-owning households (%)
Own	72.7	76.2
Rent	21.2	18.2
Other	3.7	3.8
No answer	2.5	1.8

holds with higher annual household income (Table 3). A higher percentage of pet-owning households were in the high income brackets compared with all households, and a lower percentage of pet-owning households were in the low income brackets. For example, 65% of pet-owning households had incomes more than $25,000, and 61% of all households were in the same income brackets.

A comparison of the profile of pet-owning households with all US households, according to size of household, was shown (Figure 2). Pet-owning households were more likely to be multimember households than 1-member households. Only 17.4% of pet owners were 1-member households, compared with 25% of all households in this category. In contrast, 30% of pet-owning households were ≥ 4-member households, compared with 25% of all households.

Pet ownership was higher among households that owned their home (Table 4). In addition, 76% of companion animal owners owned their home, compared with 73% of all households. On the other hand, only 18% of pet owners were renters, compared with 21% of all households.

Reference

1. Troutman CM. *The veterinary services market for companion animals, 1988.* American Veterinary Medical Association. Overland Park, Kan: Charles, Charles Research Group, August, 1988.

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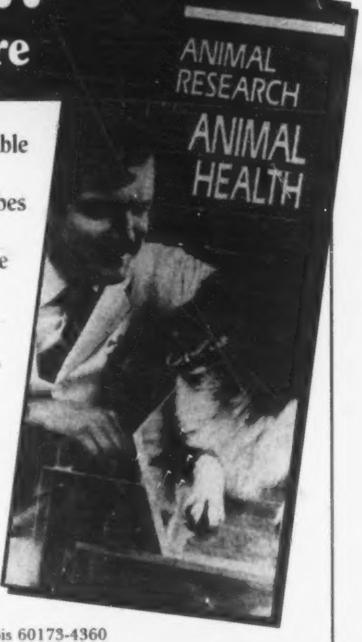

Reports of Retrospective Studies

Prepurchase evaluation of horses: 134 cases (1988-1990)

Andrew J. Dart, BVSc; Jack R. Snyder, DVM, PhD; John R. Pascoe, BVSc, PhD;
Dennis M. Meagher, DVM, PhD; W. David Wilson, BVMS, MS

Summary: *To quantify some components of prepurchase evaluations in horses, records from 134 evaluations performed during a 2-year period were reviewed and the outcome was determined via telephone follow-up interview. Sixty-two percent of the prepurchase evaluations had been performed at the clinic and 38% had been performed in the field by the ambulatory service. All evaluations included physical and lameness examinations, whereas radiography (49%), endoscopy (15%), nerve blocking (5%), transrectal palpation (3%), hematologic analysis (2%), electrocardiography (2%), drug testing for analgesic agents (2%), and ultrasonography of the flexor tendons (1%) were not always performed. Fifty-nine percent of horses evaluated at the clinic were radiographed, compared with 33% of horses evaluated in the field* ($P < 0.05$).

Thirty-seven percent of horses evaluated were judged serviceable for their intended use. Thirty-five percent of horses evaluated at the clinic were assessed to be serviceable, compared with 41% of those evaluated in the field ($P < 0.05$). *Horses used for pleasure riding (48%) tended to be considered serviceable more often than horses used for more athletic endeavors (3-day eventing, 33%; hunter/jumper, 24%; show, 31%; dressage, 30%). The most common basis for finding a horse unserviceable was lameness (88%).*

On the basis of a telephone interview, horses were divided into 5 groups: horses determined unserviceable on evaluation and not purchased ($n = 40$); *horses determined unserviceable on evaluation, purchased, and then found serviceable on follow-up interview* ($n = 35$); *horses determined unserviceable on evaluation, purchased, and then found unserviceable on follow-up interview* ($n = 9$); *horses determined serviceable on evaluation, purchased, and found serviceable on follow-up interview* ($n = 42$); *and horses determined serviceable on evaluation, purchased, and found unserviceable on follow-up interview* ($n = 8$).

The buyer and seller were present at the evaluation in 34% of cases. The buyer alone was present in 57% of cases, the seller alone in 4% of cases, whereas neither was present in 6% of cases. The potential buyer had used the horse for its intended purpose prior to the prepurchase evaluation in 39% of cases for a mean time of 20.5 days, but this did not appear to affect the serviceability of the horse on follow-up evaluation. Five horses that were leased for > 6 *months prior to purchase were all serviceable on follow-up interview, irrespective of the findings at the time of the prepurchase evaluation.*

There was a tendency for the value of horses examined at the clinic to be higher than those evaluated by the ambulatory service. The price paid by the buyer was reduced through negotiations on the basis of the prepurchase evaluation in 6% of cases.

Lameness was seen only in horses within the unserviceable group. Lameness tended to be seen more often in horses valued $> \$2,500$ *(61%, 46/75) than in horses valued* $\leq \$2,500$ *(48%, 28/59). Lameness was associated with 92% (22/24) of horses valued at* $> \$2,500$ *within the group judged to be unserviceable and not purchased.*

Radiography was performed to investigate a specific lameness in 24% (32/134) of evaluations and for survey purposes in 25% (34/134) of evaluations. Of horses radiographed within the unserviceable group, radiography commonly was performed for specific lameness (84%, 32/38) and rarely for survey purposes (24%, 9/38), whereas only survey radiographs were obtained from the serviceable group because no horses exhibited a specific lameness. Radiography was significantly ($P < 0.05$) *more likely to have been performed in horses valued* $> \$2,500$ *(65%, 49/75) than in those valued* $< \$2,500$ *(29%, 17/59), and this trend was reflected in all categories. For survey radiographs, the combination of tarsi and bilateral distal forelimbs was the most commonly radiographed area (44%). Bilateral distal forelimbs alone were the second most commonly radiographed area (41%).*

A written report summarizing the findings of the evaluation was furnished in 24% of cases. At the time of follow-up interview, 75% of buyers indicated that they would have liked a written report.

From the Veterinary Medical Teaching Hospital (Dart), and the Departments of Surgery (Snyder, Pascoe, Meagher) and Medicine (Wilson), School of Veterinary Medicine, University of California, Davis, CA 95616.

Address reprint requests to Dr. Snyder.

Soundness examinations, prepurchase examinations, or veterinary checks have long been performed by veterinarians.[1] Because of legal ramifications, veterinarians have preferred to define a horse as being serviceable or suitable rather than sound. Suitability is a "term of art" intended to mean temperament, and a specific person's ability to use that horse for an intended task.[2] Serviceable may be a more useful term because it implies the relationship of physical ability to intended use and is more likely to fall within the scope of a veterinary examination.[2]

As the value of performance horses has increased each year, so has the potential for litigation. Consequently, it appears that some veterinarians are avoiding these prepurchase evaluations, and there are vastly differing opinions on the performance and reporting of results from these evaluations.

In the 1960s, the American Association of Equine Practitioners (AAEP) made attempts to define and standardize procedures to be performed in prepurchase evaluations and the method by which results should be reported. In 1979, when the AAEP was about to officially implement these guidelines, it was decided that if a veterinarian did not follow the guidelines exactly, there would be the potential for litigation.[3] Consequently, without set guidelines and with the move toward specialization in various veterinary disciplines, the opinion on what fulfills an adequate prepurchase evaluation and the method by which these results should be reported varies widely.

The purpose of the study reported here was to review a series of prepurchase evaluations performed at the teaching hospital to quantify some of the components of these evaluations and examine the data as it relates to outcome.

Materials and Methods

Medical records of all prepurchase evaluations performed by veterinarians at the teaching hospital during a 2-year period between January 1988 and January 1990 were retrieved. The information that was recorded included: the intended use of the horse, whether the evaluation was performed by the ambulatory service or at the clinic, the clinician performing the evaluation, the procedures included in the evaluation, whether the evaluation was completed or stopped, whether a radiographic examination was performed, and whether the radiographic examination was specifically for a lameness or blemish or for survey purposes. It was also recorded whether the horse was determined to be serviceable or unserviceable for its intended use, and, if found to be unserviceable, the reason why.

All complete records were included for telephone follow-up interview. Information recorded from the follow-up interview included: whether the client was the buyer or seller, whether the client was a regular teaching hospital client, whether the buyer had taken the horse and used it for its intended purpose for a period of 2 days or longer, whether the buyer or buyer's agent, seller or seller's agent, both, or neither were present at the evaluation, whether the client had a prepurchase evaluation performed by another veterinarian before or after evaluation at the teaching hospital and the outcome of this evaluation, the asking price of the horse, the paid price for the horse and, if the price was reduced, whether it was related to the findings of the prepurchase evaluation, the present use of the horse, and whether there had been any problems with the horse since purchase. Clients also were asked whether they had received a written report and whether they would like a written report on the findings of a prepurchase evaluation of any horse they purchased.

Evaluation of medical records and follow-up interviews were completed for 134 horses. The χ^2 test for independence was used to test for differences between the groups. Differences were considered significant at a P value < 0.05.

Results

Thirty-seven veterinarians had performed the 134 prepurchase evaluations. Sixty-two percent (n = 83) of the evaluations had been performed at the clinic and 38% (n = 51) had been performed in the field by the ambulatory service. The procedure for a prepurchase evaluation included: a visual inspection and thorough physical examination that included thoracic and abdominal auscultation and ophthalmic examination, lameness examination with flexion tests, and ancillary tests if deemed necessary by the veterinarian and approved by the parties involved in the evaluation or requested by the parties. The lameness examination was not performed with the rider on the horse's back and was limited to trotting and lunging of the horse. Evaluations were completed on 88% (n = 118) of horses, but were stopped during the evaluation on 12% (n = 16) of horses because of finding something that would cause the horse to be unserviceable for its intended use. Reasons for stopping the evaluation included lameness (n = 12), eye conditions (n = 2), and respiratory tract infections (n = 2).

Ancillary tests performed included radiography (49%, n = 66), endoscopy (15%, n = 20), nerve blocking (5%, n = 7), transrectal palpation (3%, n = 4), hematologic analysis (2%, n = 2), electrocardiography (2%, n = 2), drug testing for analgesic agents (2%, n = 2), and ultrasonography of the flexor tendons (1%, n = 1). Fifty-nine percent (n = 49) of the horses examined at the clinic were radiographed, compared with 33% (n = 17) of horses seen by the ambulatory service ($P < 0.05$). All other ancillary tests were performed only on horses admitted for evaluation at the clinic.

Of the 134 horses, 50 (37%) were judged to be serviceable, whereas 84 (63%) were unserviceable.

Thirty-five percent ($n = 29$) of horses evaluated at the clinic were assessed as serviceable, compared with 41% ($n = 21$) of those evaluated in the field by the ambulatory service ($P < 0.05$).

Horses that were to be used for pleasure and trail riding tended to be assessed as serviceable more often (48%, 22/46) than all horses evaluated (37%, 50/134), whereas horses used for more athletic endeavors such as 3-day eventing (33%, 8/24), hunter/jumper (24%, 5/21), show (31%, 4/13), or dressage (30%, 3/10) tended to be assessed as serviceable less frequently (Table 1).

Lameness on the day of evaluation was the basis for finding a horse unserviceable in 88% (74/84) of cases, whereas 7% (6/84) of the horses were assessed as unserviceable on the basis of findings on survey radiography even though they were not lame. Four of 20 (5%) horses were assessed as unserviceable because of other conditions (2 with eye problems and 2 with respiratory tract infections).

On the basis of the follow-up interview, horses were subdivided into 5 groups (Table 2). Group 1 included horses unserviceable on evaluation and not purchased ($n = 40$). Group-2 horses had been deemed unserviceable but had been purchased despite findings of the evaluation, and were then found to be serviceable on follow-up interview ($n = 35$). Horses in group 3 had been found unserviceable on evaluation, purchased, and found to be unserviceable on follow-up interview ($n = 9$). Group 4 included horses found to be serviceable on evaluation, purchased, and found to be serviceable on follow-up interview ($n = 42$), and group 5 included horses found to be serviceable on evaluation, purchased, but found to be unserviceable on follow-up interview ($n = 8$).

All prepurchase evaluations had been performed on behalf of the buyer; thus, long-term serviceability of horses in group 1 could not be determined because these horses were not purchased and were lost to follow-up evaluation.

The buyer or buyer's agent and the seller or seller's agent were present in 34% ($n = 45$) of evaluations. The buyer or buyer's agents were present in 57% ($n = 76$) of evaluations, whereas the seller or seller's agent alone were present in 4% ($n = 5$) of evaluations. Neither party was present in 6% ($n = 8$) of evaluations. Buyers were regular teaching hospital clients in 66% ($n = 89$) of the 134 evaluations.

Horses were used for the intended purpose by the potential buyer prior to the prepurchase evaluation in 39% ($n = 52$) of the evaluations. Of all horses purchased, irrespective of the findings of the evaluation, 42% ($n = 35$) were used by the potential buyer for their intended purpose prior to the evaluation. Thirty-eight percent (29/77) of horses purchased and found to be unserviceable on follow-up interview (groups 2 and 4) had been used for the intended purpose prior to purchase. This did not differ significantly from those horses that had been used by the potential buyer for their intended purpose prior to the evaluation and were purchased but were later found to be unserviceable (35%, 6/17).

Table 1—Intended use and number classified as serviceable for 134 horses undergoing prepurchase evaluation at the University of California Veterinary Medical Teaching Hospital

Intended use	No. evaluated (%)	No. serviceable (%)
Pleasure/trail	46 (34)	22 (48)
3-day eventing	24 (18)	8 (33)
Hunter/jumper	21 (16)	5 (24)
Show/english/western pleasure	13 (10)	4 (31)
Dressage	10 (7)	3 (30)
Thoroughbred racing	4 (3)	0 (0)
Endurance	4 (3)	2 (50)
Barrel racing	4 (3)	2 (50)
Roping	4 (3)	1 (25)
Schooling	2 (1.5)	1 (50)
Broodmare	2 (1.5)	2 (100)

The length of time that horses were used by the potential buyer prior to the prepurchase evaluation ranged from 2 to 90 days (mean, 20.5 ± 22.7 days). Five horses that were leased for periods between 6 months and 2 years by the potential buyer were not included in this analysis. Two of these horses were assessed as serviceable at the prepurchase evaluation and 3 were assessed as unserviceable on the basis of lameness on the day of evaluation. All 5 horses were purchased despite the findings of the evaluation and were found to be serviceable for their intended purpose on follow-up interview.

One horse that was assessed as unserviceable because of evidence of lameness during the evaluation at the teaching hospital was subsequently examined by a second veterinarian at another clinic who assessed the horse to be serviceable. The horse was purchased and was serviceable for its intended use on follow-up interview.

The price asked for the horse by the seller was reduced through negotiation on the basis of the findings of the prepurchase evaluation in 6% (5/94) of cases where the horse was purchased. The mean value of horses examined was \$6,554.85 ± \$13,961.76 (range, \$0.00 to \$150,000.00). The mean value of horses examined by the ambulatory service (\$2,741.18 ± \$2,889.86; range, \$0.00 to \$15,000.00) tended to be lower than the mean value of horses examined at the clinic (\$8,771.08 ± \$17,227.49; range, \$0.00 to \$15,000.00).

Forty-four percent ($n = 59$) of all horses seen were valued at ≤ \$2,500 and 56% ($n = 75$) were > \$2,500. The ambulatory service evaluated 51 horses, of which 63% ($n = 32$) were ≤ \$2,500 and 37% ($n = 19$) were > \$2,500. Of the 83 horses examined at the clinic, 33% ($n = 27$) were ≤ \$2,500, whereas 68% ($n = 56$) were > \$2,500.

Lameness was identified only in horses assessed as unserviceable on evaluation and was not

Table 2—Lameness and radiography results of prepurchase evaluation of 134 horses

Horses Groups*	All horses					Horses valued at ≤ $2,500					Horses valued at > $2,500				
			Radiography performed					Radiography performed					Radiography performed		
	Total	Lame	No.	for lameness	for survey	Total	Lame	No.	for lameness	for survey	Total	Lame	No.	for lameness	for survey
All	134	74	66	32	34	59	28	17	7	10	75	46	49	25	24
Unserviceable	84	74	38	32	6	32	28	7	7	0	52	46	31	25	6
Group 1	40	36	19	16	3	16	14	3	3	0	24	22	16	13	3
Group 2	35	29	13	13	3	13	11	4	4	0	22	18	9	9	0
Group 3	9	9	6	3	0	3	3	0	0	0	6	6	6	3	3
Serviceable	50	0	28	0	28	27	0	10	0	10	23	0	18	0	18
Group 4	42	0	22	0	22	23	0	8	0	8	19	0	14	0	14
Group 5	8	0	6	0	6	4	0	2	0	2	4	0	4	0	4

*Group 1—Horses unserviceable at evaluation and not purchased; Group 2—Horses unserviceable at evaluation, purchased, and found to be serviceable on telephone follow up; Group 3—Horses unserviceable at evaluation, purchased, and found to be unserviceable on telephone follow up; Group 4—Horses serviceable at evaluation, purchased, and found to be serviceable on telephone follow up; Group 5—Horses serviceable at evaluation, purchased, and found to be unserviceable on telephone follow up.

detected in horses assessed as serviceable (Table 2). Lameness tended to be seen more often in horses valued at > $2,500 (61%, 46/75) than in horses valued at ≤ $2,500 (48%, 28/59). Lameness in horses valued at > $2,500 was associated with the high prevalence of lameness in horses within group 1 (90%, 36/40) and particularly those within group 1 that were valued at > $2,500 (92%, 22/24).

Radiographs were obtained specifically to investigate lameness in 24% (32/134) of all horses evaluated, whereas survey radiographs were taken in 25% (34/134) of all horses evaluated (Table 2). Within the unserviceable groups (groups 1 to 3), horses were radiographed most commonly because of specific lameness (84%, 32/38) and rarely for survey purposes (16%, 6/38), whereas horses in the serviceable groups (group 4 and 5) only had survey radiographs taken.

Numbers of horses radiographed specifically for lameness (24%, 32/134) was significantly ($P < 0.05$) lower than the number of horses determined to be lame (55%, 74/134). This was true for horses valued at ≤ $2,500 or > $2,500 and for all groups of unserviceable horses.

Radiographs were significantly ($P < 0.05$) more likely to have been taken in horses valued at > $2,500 (65%, 49/75) than in horses valued at < $2,500 (29%, 17/59). This trend was reflected within all groups of horses deemed to be serviceable (groups 4 and 5) and unserviceable (groups 1 to 3) on evaluation. Within the unserviceable group (groups 1 to 3), the frequency of radiographic examination of horses in both price ranges did not differ on the basis of whether the horse was purchased or not.

Survey radiography was performed on 34 horses. The most commonly radiographed areas were a combination of tarsi and bilateral distal forelimbs (44%, 15/34), and bilateral metacarpophalangeal joints, and bilateral distal forelimbs (6%, 2/34) or carpi, bilateral metacarpophalangeal joints, and bilateral distal forelimbs (3%, 1/34).

All horses found to be serviceable at the time of telephone follow-up interview were being used for their intended purpose without complication. Of 9 horses in group 3, 7 had lameness problems directly associated with problems detected at the prepurchase evaluation. Three of these horses also had evidence of degenerative joint disease on radiographs taken at the prepurchase evaluation. The 4 other horses did not have radiography performed. One horse in group 3 was not being used because of bad temperament. Another horse in group 3 that had been found to have a forelimb lameness during the prepurchase evaluation was later found by another veterinarian to have a lameness of the stifle that precluded further use. Of the 8 horses in group 5, 3 were not being used because of bad temperament, 2 had lameness originating from the tarsi (both had normal radiographs of the tarsi at the prepurchase evaluation), 1 had developed a lameness of the forelimbs bilaterally, which originated from the distal extremities. This horse had had a normal radiographic examination of the distal forelimbs at the prepurchase evaluation. One horse in group 5 had developed a severe superficial flexor tendonitis. Radiographically, the horse had mild lesions of the navicular bone at the time of the prepurchase evaluation. One horse in group 5 that had not had radiography performed during the prepurchase evaluation had developed laminitis without rotation.

A written report summarizing the findings of the evaluation was furnished in 24% (32/134) of cases. On telephone follow-up interview, 75% (101/134) buyers indicated that they would like a written summary of the evaluation for horses they purchase.

Discussion

Other reports and panel discussions on prepurchase evaluations have been based on personal experiences of veterinarians from private practice and university clinics.[1-11] Consequently, just as the use and value of horses being evaluated and the amount of information a potential purchaser expects differ between practices, so does the opinion of veterinarians on what should comprise a prepurchase evaluation and how the results of the evaluation should be reported. The study reported here attempted to evaluate a series of prepurchase evaluations to assess the findings as they relate to the long-term serviceability of the horse for its intended use. The limitation of our study is that it represented the results of only some aspects of prepurchase evaluations at a single hospital. The examinations, however, were performed under field conditions and within the clinic by 37 veterinarians with a variety of veterinary and equine-related backgrounds. They also were performed on horses having a wide variety of uses and values.

The procedures believed to be necessary for prepurchase evaluation vary greatly between investigators. Reid[10] suggested that a veterinarian is not obligated to use radiography. Soule[2] stated that endoscopic examination of the upper airway is mandatory when he performs a prepurchase evaluation, whereas Beeman[9] suggested that it is only necessary if indicated. There also is some debate on whether the risks of transrectal palpation outweigh the benefits when performed on horses whose intended purpose is not breeding.[2,9] Moyer and Abbott[4] stated that they see no reason not to perform a less than ideal examination if the buyer requested it and if they are given the opportunity to state such in a letter. Beeman[9] agreed with this in essence; however, he stated that legal problems may arise if the purchaser finds a problem after purchase of which he or she was not made aware at the time of examination. This puts the veterinarian performing the evaluation in the difficult position of choosing which ancillary tests should be used to determine the potential serviceability of a particular horse, while remaining within the financial constraints of the buyer. It was interesting that in the study reported here, ancillary procedures, in particular, radiography and endoscopy, were performed far less frequently than we had anticipated, despite the fact that these procedures were readily available. Many potential buyers may be satisfied with thorough physical and lameness examinations and are not financially interested in pursuing other diagnostic services. Beeman[9] suggested that to accomplish an evaluation at any level, it is essential to have the proper equipment or have knowledge of referral centers where it can be obtained.[9]

In our study, it appeared that having the equipment available to perform an evaluation at any level requested by the purchaser or deemed necessary by the veterinarian, within the financial limits of the purchaser, was of greater importance than the performance of the same evaluation on every horse. We agree with other investigators[4,5,7] that communication to the prospective buyer of the limitations of the evaluation is important.

There was a tendency for horses evaluated by the ambulatory service to be found serviceable more often (41%) than those evaluated in the clinic (35%). This may be attributable to the fact that ancillary diagnostic tests were performed more frequently in the clinic, which facilitated a more thorough evaluation, compared with that performed in the field. This also would be consistent with the higher frequency of radiographic examinations performed at the clinic (59%) compared with that on horses in the field (33%). It is possible that clinicians on the ambulatory service were less likely to pursue radiography because of the difficulty associated with getting an adequate, complete diagnostic series of films in the field with a portable X-ray unit. Alternatively, the tendency for horses examined by the ambulatory service to be lower in value than those seen in the clinic may reflect that potential buyers of less expensive horses are less likely to invest in ancillary diagnostic tests.

Other investigators[1,8,9] have stressed that veterinarians evaluating a horse should have a thorough knowledge of the intended purpose of the horse. Although referral may be an option, some clients may find it more convenient and may be more comfortable with their regular veterinarian conducting the prepurchase evaluation, even when that veterinarian has limited experience with a particular equestrian discipline. Potential buyers of horses in our study were regular teaching hospital clients in 66% of cases, and in a private practice, this percentage is likely to be higher; thus, the veterinarian is likely to be familiar with the buyer's motives for purchasing the horse.

Preferences regarding who should be present at the examination as well as the relationship and obligations of the veterinarian to the buyer and seller differ among veterinarians.[2,4,9] Beeman[9] insisted that the buyer and seller be present, and Moyer and Abbott[4] stressed the potential for legal complications if the seller is not present and a problem develops with the horse during the examination. We prefer that all parties be present at the examination to avoid legal complications and encourage open communication; however, this is not always possible, as evidenced by the study reported here. Both parties were present in only 34% of examinations, whereas the buyer alone was present in 58% of cases. Horses were examined when neither was present in 6% of cases. For all horses in our study, the client was the potential buyer. It is generally agreed that to avoid a conflict of interest it is best not to examine a horse for the seller, particularly if the seller is a regular client.[2,4,9] Soule[2] suggested that it is difficult to know what a stranger expects from an examination; thus, he rarely examines a horse for a client he does not know. Soule[2] and Moyer and Abbott[4] have addressed the need to have a working knowledge of the intended purpose of the horse and to have the potential buyer work the horse during the lameness examination. Beeman,[9] however, suggested that to limit the legal ramifications associated with either the horse or rider being injured during the examination, a horse should be thoroughly tried and in the hands of the potential buyer for at least 72 hours.

He also suggested that the ability of a horse to perform is not the responsibility of the veterinarian. In our study, horses were used for the intended purpose by the potential buyer before the prepurchase evaluation in only 39% of cases; however, the mean time that the horses were used on trial was 20.5 days. Although use of the horses for this period did not affect serviceability on follow-up interview (used and serviceable, 38%; used and unserviceable, 35%) all 5 horses leased for at least 6 months prior to purchase were serviceable on follow-up interview, irrespective of the findings of the prepurchase evaluation. This may suggest that there is some benefit for the potential purchaser to have at least closely observed, if not leased, the horse for an extended time prior to evaluation.

There was a tendency for horses that were to be used for pleasure/trail riding to be assessed as serviceable on evaluation (48%) more frequently than all horses found serviceable (37%). Conversely, horses used for more athletic purposes, such as 3-day eventing (33%), hunter/jumper (24%), show/english and western pleasure (31%), and dressage (30%), had a tendency to be found serviceable less frequently. Lameness on the day of evaluation (88%) was the most common reason horses were found unserviceable. Lameness was not detected in any horses found to be serviceable, suggesting that lameness was reason to find a horse unserviceable irrespective of the intended purpose. There was a tendency for lameness to be identified more frequently in horses valued at > $2,500 (61%), compared with those valued at < 2,500 (48%). A high number of lamenesses (36/40) was detected within horses in group 1, specifically those valued at > $2,500. Radiography was more likely to have been performed on horses valued at > $2,500. It is likely that more valuable horses have athletic purposes and consequently are at greater risk for lameness problems. The value of these horses may be such that the potential buyer sees a need and is in a financial position to permit a more extensive evaluation. Consequently, it is likely that the more strenuous or precise the intended activity, the more important minor abnormalities become. This may be why there was a tendency for a higher percentage of pleasure and trail horses to be found serviceable, compared with those used for more athletic endeavors.

Reid[10] has stated that if survey radiography is to be performed, potential areas of future unsoundness should be targeted. It generally is accepted that the front feet and tarsi often are prone to degenerative changes.[2,10] On the basis of results of the study reported here, these areas were the most frequently radiographed.

The most notable finding in our study was the serviceability of horses on follow-up interview. Horses within the unserviceable on evaluation and not purchased group were effectively lost to follow-up evaluation. Of those horses found unserviceable on evaluation, 52% were purchased despite the findings of the evaluation. This suggested that in many cases, potential buyers had decided to buy a horse regardless of the result of the prepurchase evaluation. Of the horses found to be unserviceable and purchased, 80% were later said to be serviceable for their intended use. Because the most common grounds for finding a horse unserviceable on evaluation was lameness, it appeared that many horses found unserviceable on the basis of lameness on the day of evaluation were, in fact, potentially serviceable. Determination of lameness may be related to the degree of difficulty of the evaluation or the surface on which the work is being performed. The lameness also may have been transient, thus not affecting long-term serviceability of the horse. Horses found lame on evaluation should be reevaluated at a later date if requested by the parties involved. In some cases, lameness may not be grounds for finding a horse unserviceable for its intended use if this is acceptable to the owner. Eighty-four percent of horses found to be serviceable on initial evaluation were found to be serviceable on follow-up interview. Although this percentage of horses is not significantly different from the number of horses found unserviceable, purchased, and found to be serviceable on follow-up interview, it is worth noting that 48% of those horses found to be unserviceable on evaluation were not purchased on the basis of evaluation, and thus, were lost to follow-up evaluation. Therefore, from our study, it is not possible to assess the reliability of the prepurchase evaluation as it is performed at our hospital for predicting serviceability of a horse for its intended use.

Many veterinarians involved in the early attempts to define guidelines for prepurchase evaluations looked toward developing an evaluation form,[1,5,8] but others have moved away from issuing a certificate because they believe that the results of a prepurchase evaluation should not be delivered as a pass/fail or serviceable/not serviceable judgment.[2,4,9] The veterinarian should act in an advisory capacity, providing a verbal report to the potential buyer with the information necessary to make an educated decision. The number of horses found to be serviceable for the intended purpose at the follow-up interview despite being found unserviceable on examination in the study reported here would stress the need not to pass or fail a horse and to be careful about finding a horse unserviceable on the basis of 1 examination. Rendering a negative judgment may adversely affect the value of horses with transient problems that do not affect their long-term serviceability, and may also cause animosity between the parties involved in the sale and between the parties and the veterinarian.

Moyer and Abbott[4] have outlined how they prefer to write a letter outlining findings of a prepurchase evaluation, and Bonnie[3] has discussed the legal implications. In our study, a written report on the evaluation was furnished in only 24% of cases. On follow-up interview, 75% of clients said they would have liked a written report. In all cases, clients specified that this would be useful only as part of their medical records.

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Book Review:
Anatomy and Physiology of Farm Animals. 5th Edition

This text represents a well-organized, well-illustrated, and well-indexed source of anatomy and physiology of common domestic mammals. In a time when text books are increasingly voluminous, it presents the anatomy and physiology in about 530 pages, including many illustrations. It has, for several years, been useful as an introduction to these subjects for students of animal science. Until recently, it has been the only text available for this purpose, and has served this responsibility reasonably well. The anatomic principles have traditionally been well presented in this text, whereas the presentation of physiologic principles has traditionally been weak. As physiologic concepts continue to evolve, the text has not pursued them, but has retained ideas that are no longer acceptable. The current edition demonstrates some improvement over the 4th edition in the correction of some errors and misunderstandings. This text would be useful to undergraduate animal science students for its anatomic concepts alone. To consider the text acceptable, however, even as an adequate introduction to physiology, would be an error. Many currently accepted physiologic concepts and facts are simply misrepresented or are not presented at all.

Although there are many illustrations and tables of good quality, many, illustrating physiologic concepts, should be updated, along with the text, to represent current concepts. Many of these, such as Table 10-1, which indicates that parasympathetic N.S. produces vasodilatation in skeletal muscle, and Figure 14-9 indicating that the kidney produces a factor that with plasma globulins results in erthyropoietin, are simply in error. Errors such as these are too numerous to enumerate in this review.

The preface indicates that the author has attempted to make this text more useful to veterinary students and practitioners without sacrificing the simplicity and clarity desirable in an undergraduate text. This has been accomplished, and the text would serve its ends well if it were more factual. Throughout the text, in all sections, including those rewritten by the co-author, there are serious errors of fact and concept that could easily have been corrected by the eye of a physiologist.—[*Anatomy and Physiology of Farm Animals. 5th Edition. By R. D. Frandson and T. L. Spurgeon. 572 pages; illustrated. Lea & Febiger, PO Box 3024, 200 Chester Field Parkway, Malvern, PA 19355-9725. 1992. Price $47.95.*]—JAMES E. BREAZILE

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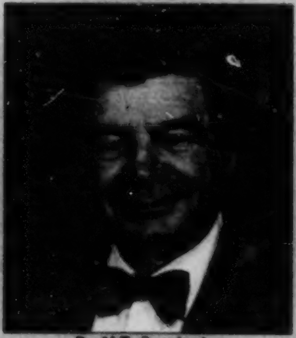

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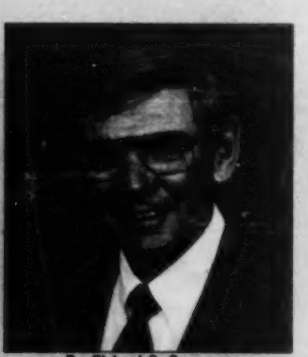

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Vol 201 October 15, 1992 No. 8
JAVMA 201 (8) 1129-1304
ISSN 0003-1488

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SUBSCRIPTIONS: For one year: members $50; others $100 in the United States and possessions; $120 in foreign countries. Single copies: $6 in the United States and possessions; $8 in foreign countries.

Published semimonthly at 1931 N Meacham Rd, Suite 100, Schaumburg, IL 60173-4360, by the American Veterinary Medical Association. Second class postage paid at Schaumburg, Ill, and at additional mailing offices. Contents copyright 1992 by the AVMA.

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The Information Exchange

Veterinary Service Market for Companion Animals, 1992

Part II: Veterinary service use and expenditures

This is the second of a 2-part series summarizing findings from the complete report available from the AVMA Center for Information Management.

In 1992, the AVMA Center for Information Management conducted a nationwide study of 80,000 US households to update, expand, and report information on the companion animal market for veterinary medical services. The response rate was 68.9%, and the respondent group was analyzed and determined to be a representative sample of US households. Detailed results of this study are included in the report entitled *Veterinary Service Market for Companion Animals, 1992*.

The estimated population of companion animals and a demographic profile of pet owners were reported in a previous article.[1] Use of veterinary services, frequency of veterinary visits, and veterinary medical expenditures are reported here.

Use of Veterinary Services

Analysis focused on use of veterinary medical services, including whether the pet owner had a veterinarian, reasons for selecting a veterinarian, services and products provided, level of satisfaction, and the pet owner's opinion regarding the best source of health care knowledge and advice regarding his/her type of pet.

It was determined that 79.6% of dog owners, 70.2% of cat owners, and 67.9% of horse owners had a veterinarian. Only 21.0% of bird owners indicated that they had a veterinarian. These findings imply that at least 20% of dog, cat, and horse owners, and nearly 80% of bird owners do not currently have a veterinarian. The veterinary medical profession, through additional market segmentation analysis and strategic marketing, has the potential to reach these animal owners and expand the delivery of services.

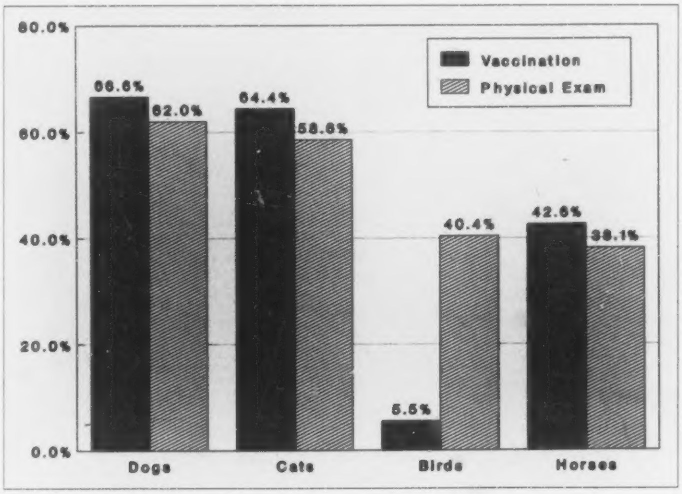

Figure 1—Services provided at last veterinary visit, 1991.

For each type of companion animal owned, respondents were asked about the services and products that were provided during the last visit with the veterinarian. Although many types of services and products are provided by veterinarians, Figure 1 shows that physical examinations and vaccinations were the most commonly provided services. Approximately 62% of dog owners, 59% of cat owners, 40% of bird owners, and 38% of horse owners indicated that a physical examination was provided at the animal's last veterinary visit. With the exception of birds, slightly higher percentages of owners indicated that the animal was vaccinated at the last visit.

Further analysis revealed that 90.5% of dog owners, 90.7% of cat owners, 87.0% of bird owners, and 93.6% of

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From the AVMA Center for Information Management; J. Karl Wise, PhD, Director; Jih-Jing Yang, PhD, Research Analyst.

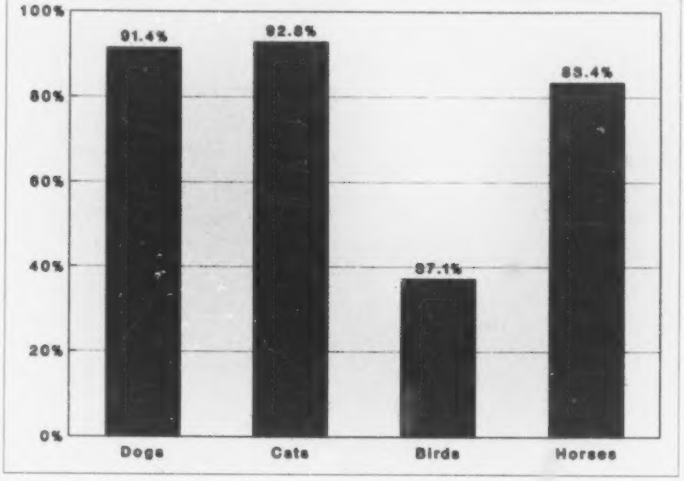

Figure 2—Veterinarian as the best source of health care knowledge and advice, 1991.

Table 1—Households obtaining veterinary care, 1987, 1991

Pet	Households obtaining veterinary care (%)		Mean veterinary visits per household (No.)	
	1987	1991	1987	1991
Dog	77.6	82.3	2.37	2.64
Cat	59.5	62.4	1.62	1.78
Bird	7.6	10.6	0.15	0.22
Horse	47.4	53.6	1.85	2.40
Other	9.9	10.3	...	...

horse owners were satisfied with the last veterinary visit.

These findings, suggesting high use of preventive medical services and high levels of satisfaction with services provided by veterinarians, confirm that veterinarians and companion animal owners have developed excellent rapport and responsible health care programs for companion animals.

Companion animal owners also were requested to indicate whether the breeder, pet store, trainer, or veterinarian was their best source of health care knowledge and advice. Figure 2 shows that over 90% of dog and cat owners and approximately 83% of horse owners indicated that the veterinarian was the best source of health care knowledge and advice.

On the other hand, < 4 of 10 bird owners ranked the veterinarian as the best source of health care knowledge and advice. At least 4 of 10 bird owners regarded the pet store as the best source of health care advice. Coupled with the fact that nearly 80% of bird owners reported not having a veterinarian, these findings reveal that the veterinary medical service market for birds represents a significant marketing challenge for the profession.

Veterinary Service Visits and Expenditures

All companion animal owners were requested to indicate the number of times their animals were seen by a veterinarian in 1991. If a respondent owned 2 dogs and each dog was seen twice during the year, the respondent was instructed to report 4 visits.

Table 1 shows that for dogs, cats, birds, and horses, the proportion of households obtaining veterinary care in 1991 increased from 1987.[2] Specifically, 82% of dog-owning households, 62% of cat-owning households, nearly 11% of bird-owning households, and nearly 54% of horse-owning households obtained veterinary care in 1991.

Table 2—Mean veterinary service expenditure per household, 1987, 1991

Pet	1987 ($)	1991 ($)
Dog	82.68	131.84
Cat	54.28	79.75
Bird	4.47	34.24
Horse	120.75	163.23
Other	7.74	9.05

Not only did increased proportions of companion animal owners obtain veterinary care in 1991, but they obtained veterinary care more times in 1991 (Table 1). Mean veterinary visits per household for dogs was 2.64 visits per year in 1991, up from 2.37 visits per year in 1987. For cats, mean veterinary visits per household was 1.78 visits per year in 1991, up from 1.62 visits per year in 1987. Mean visits per household for birds was 0.22 visits per year in 1991, up from 0.15 in 1987. For horses, mean visits per household was 2.40 visits per year in 1991, up from 1.85 in 1987.

Total veterinary expenditures in 1991 were estimated for each type of companion animal owned by the household. In 1987, veterinary expenditures also were estimated, but were calculated differently (ie, veterinary expenditures for each type of pet were calculated from data for households owning one type of pet exclusively). In the 1992 study, households reported annual veterinary expenditures for each type of pet owned. This method is believed to provide a more accurate estimate of veterinary expenditures in 1991.

Consistent with increased visits per household, dog-owning households spent more at the veterinarian in 1991 than in 1987. Mean veterinary expenditure for dogs per dog-owning household was $131.84 in 1991, up from $82.68 in 1987 (Table 2). Mean 1991 veterinary expenditures were $79.75 for cat-owning households, $34.24 for bird-owning households, and $163.23 for horse-owning households.

On the basis of estimated veterinary expenditures and the number of animal-owning households in the United States, one can estimate the total expenditures for veterinary services for dogs, cats, birds, and horses owned by households in the United States. Veterinary expenditures in 1991 were nearly $4.6 billion for dogs, approximately $2.3 billion for cats, $185 million for birds, and $314 million for horses.

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